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May 8, 1996

Mr. Leonard Gelman
Mr. Jack Grady
U.S. Department of Justice
Environmental Enforcement Sec.
P. O. Box 7611
Ben Franklin Station
Washington, D.C. 20044-761

Re: United States vs. NL Industries, Inc. et al
Docket No. 91-578-JLF

Dear Gentlemen:

You have advised the USEPA intends to proceed with additional soil remediation of properties in Granite City, and have asked the City's permission to allow the USEPA to remediate the easements or right-of-ways contiguous to the subject properties. At the present time, for a variety of reasons, the City cannot concede to the USEPA's request.

The City and defendants are submitting the Bornschein study for inclusion in the administrative record pursuant to 40 C.F.R. S300.825 (c), a copy of which is attached hereto. The study is just now completed. The NCP provides that the administrative record shall be supplemented to the extent that proffered documents contain significant information not contained elsewhere in the record, which could not have been submitted during the public comment period, and which substantially support the need to significantly alter the response action.

The Bornschein study falls squarely within this section. It contains significant information concerning the actual effect of the USEPA's cleanup plan in Granite City. Such firsthand information is unavailable elsewhere in the record. Additionally, this information could not have been submitted during the public comment period because the study has only recently been completed. Finally, Dr. Bornschein's study substantially

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supports the need to significantly alter the response action because it shows that the USEPA's chosen remedy has been ineffective in reducing children's exposure to lead in homes.

Dr. Bornschein's study is of utmost importance to Granite City and goes to the heart of many of the issues in this case. One issue repeatedly raised by the City is that the pile needs to be addressed before the remediation of residences. Dr. Bornschein's study shows that the lead levels in the streets, attributable to the pile, are enormous. This is further confirmation of the conclusion reached by the convention of experts in their Consensus Statements dated January 13, 1995, and February 7, 1995, that the pile "has been and will continue to be a significant potential lead source in the community: this source is potentially highly mobile and therefore requires vigorous intervention to prevent continuing community contamination."

The City has previously stated and holds firm to the position there should be no soil remediation until all appropriate actions with regard to the lead pile have been taken. The City strongly believes it is pointless in the first instance to engage in substantial soil remediation of properties, and it makes even less sense knowing those properties will be contaminated at some later time. It continues to be the City's contention the USEPA should focus its immediate remediation efforts towards the lead pile.

Sincerely,

Edward C. Fitzhenry

ECF/alb

21162.1

The Effectiveness of Soil Removal on Lead Exposure in Granite City

April, 1996

R. Bornschein

University of Cincinnati

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1 Executive Summary

This report details the findings of a study of environmental lead levels in Granite City Illinois commissioned by the City and conducted by the University of Cincinnati. U.S. EPA has declared Granite City a Superfund site because of lead contamination allegedly stemming from the operation of the now defunct smelter located at the NL Taracorp plant. During 1993 and 1994, the Agency removed contaminated soil from the yards of 38 dwellings.

Granite City commissioned the University of Cincinnati study of environmental lead in the City to evaluate EPA's remedial approach. Specifically, the study was designed to determine if the removal of soil from residential yards would substantially reduce the risk of further lead exposure to the residents Granite City. As part of that objective, the study investigated if the remedial action already taken by EPA had effectively reduced housedust lead levels. The study also searched for additional lead sources that may contaminate interior housedust, a medium thought to be especially responsible for lead exposure among children. Finally, the University of Cincinnati study investigated the accuracy of paint lead concentration values reported in a study conducted by the Illinois Department of Health (Illinois DOH). That study utilized a Gamma-Tech XRF device, rather than more recently developed XRF devices. The University of Cincinnati compared the results reported by Illinois DOH to results recorded by the recently developed SciTec XRF device.

To fully characterize environmental lead exposure in Granite City, the University of Cincinn recorded the following information: 1) interior surface dust lead levels, 2) 30-day dustfall rates; 3) Interior entry mat dust lead loading levels; 4) Alley dust lead levels; 5) Exterior dust lead levels; and 6) soil lead levels. To evaluate the paint lead concentration results reported by Illinois DOH, the University of Cincinnati sampled paint lead levels using the SciTec XRF device.

The study results revealed two sources of lead contamination not considered by U.S. EPA in the Agency's formulation of a risk management strategy: lead-based residential paint, and street dust transported from the Taracorp site by either wind action or by trucks traveling from the site and through the city. Lead paint is a likely contamination source because the concentration of lead in paint is several orders of magnitude higher than the corresponding concentrations in either house dust or exterior soil; moreover, age and inadequate maintenance for many dwellings have caused lead-painted surfaces to

deteriorate and release lead paint to the environment. The fact that soil lead levels are substantially higher near dwelling "drip line" locations than soil lead levels near the street curb also points towards deteriorating lead paint as a likely candidate for lead contamination in soil. On going contamination of soil resulting from the transport of lead from the Taracorp site (by either wind action or by trucks traveling through the city from the Taracorp site) is also likely. Data detailing street dust lead levels reveal an inverse relationship with distance to the Taracorp site. Because the smelter has been inactive for over a decade, and because street dust lead stemming from the operation of the smelter would be eliminated relatively quickly (*e.g.*, by rain and street cleaning activities), it is likely that the currently observed street dust lead levels reflect current and on going contamination from the Taracorp site.

The study results also demonstrated that abatement of residential soil does not effectively reduce housedust lead levels and therefore is likely to have a minimal effect on lead exposure. In fact, interior housedust lead levels increased substantially at most of the dwellings evaluated. The study results also revealed that soil itself became recontaminated after the completion of abatement activities.

Finally, the evaluation of the Illinois DOH paint lead results using the SciTec device indicated that the DOH results were valid.

The results of the University of Cincinnati study call into question EPA's strategy of abating residential soil as a first (and perhaps only) step in the Agency's effort to reduce lead exposure in Granite City. First, the study demonstrated that there are at least two on going sources of soil contamination – deteriorating residential lead-based paint, and the continuing transport of lead from the Taracorp site. There is reason to believe that these lead sources would recontaminate abated soil. EPA's risk management recommendations are based on the Agency's use of its Integrated Exposure Uptake Biokinetic (IEUBK) model, which does not account for these sources of soil contamination. EPA's focus on soil removal alone is also questionable given that at other sites, the Agency has adopted a more holistic approach to addressing lead contamination. Second, the study results cast doubt on the efficacy of soil removal; even after soil is abated, housedust lead levels remain elevated. Third, the fact that soil becomes recontaminated after abatement confirms the hypothesis that other on going sources of lead contamination are active in Granite City and that EPA should address these sources before it considers abatement of residential soil. Finally, we note that the Illinois DOH paint lead level results are valid. Hence, the fact that Illinois DOH did not use the most up-to-date technology for this evaluation does not justify disregarding their findings.

2 Background

In the fall of 1994, the University of Cincinnati was asked by the Granite City City Council to assist the city in its evaluation of the effectiveness of soil remediation efforts currently under way on residential properties adjacent to the Taracorp Superfund site. Numerous studies and investigations have been conducted in this community by both the U.S. EPA, by ATSDR, and by outside investigators. These studies have revealed lead levels as high as several thousand μg/g in residential soils. A comprehensive blood lead level survey conducted by the Illinois Department of Health identified multiple sources and reservoirs of lead in the residential environment. Subsequent to the University of Cincinnati study conducted in the fall of 1994, Dr. Robert Bornschein, the study's lead investigator, suggested the collection of additional data. In seeking to extend the study, Dr. Bornschein stated that doing so would give his te an opportunity to increase the study sample size (since remediation of additional homes was planned) and to investigate the impact of soil recontamination over a longer period of time (two years, rather than one year). The City concurred and asked the University to continue its investigation. This report details the University's findings through the fall of 1995.

The U.S. EPA undertook soil removal on 21 properties in 1993 in an effort to address possible excessive lead exposure among residents living adjacent to the site. In the fall of 1994, the EPA remediated an additional 17 properties. However, these actions raised many questions within the community and the city administration about whether the cleanup was reducing lead exposure in any significant manner. The questions are outlined in the subsequent section.

3 Objectives

This section describes the objectives of the University of Cincinnati study of environmental lead in Granite City.

3.1 Determine if the Removal of Soil would Substantially Reduce the Risk of Further Lead Exposure to the Residents of Granite City.

The main question the University of Cincinnati study set out to investigate was whether removal of soil from residential yards in Granite City would substantially reduce lead exposure among the residents of this community. To answer this question, the University of Cincinnati assessed the impact of soil remediation on interior dust lead levels since ingestion of interior housedust is thought to be one of the main pathways by which children are exposed to lead present in soil (US Dept. of HUD, 1990; Bornschein *et al.*, 1986; Bornschein *et al.*, 1988).

This study evaluated the potential effectiveness of soil removal by measuring changes in housedust lead levels after remediation and by investigating three factors: 1) the importance of media other than soil as sources that contaminate interior housedust; 2) the short-term impact of soil removal on lead levels in key exposure media; and 3) the recontamination of remediated soils by various sources of lead in Granite City.

3.1.1 Identify Additional Lead Sources that may Contaminate Interior Housedust

Since the housing stock in Granite City is relatively old, lead-based pigment in both exterior and interior paint may directly contaminate interior dust. In such cases, removal of lead in exterior soil may not substantially affect interior dust lead levels. Since the huge lead slag piles generated during the operation of the lead smelter have not been removed, it is possible that trucks leaving the plant now occupying that site or trucks leaving the adjacent trucking company could track dust through the streets, and that this dust could directly contaminate interior housedust. Alternatively, wind could transport this source of lead into houses. Among the quantities surveyed by the study, the University of Cincinnati therefore measured the following: lead concentration of exterior (entry) dust sample; dust loading of exterior (entry) dust sample; lead concentration of the repeated exterior (entry) dust sample; lead concentration of the interior dust

sample; dust lead loading of the interior dust sample; lead concentration in the mat dust sample; lead concentration in paint chip samples; and street dust lead levels.

3.1.2 Determine the Short-Term Effectiveness of Soil Remediation on Lead Exposure as Reflected in Housedust Levels

The efficacy of soil removal can be evaluated by measuring lead exposure (*e.g.*, lead concentrations in various media) both before and after soil removal has been conducted. Such comparisons are limited since EPA has remediated soil in only a limited number of homes in Granite City. Nonetheless, comparing lead concentrations in various media provides some insight into this issue. It also permits the investigation of whether soil removal activities actually increase lead levels in various exposure media by disturbing lead and creating fugitive sources of lead contaminated dust. To address this issue, the study measured the following both before and after soil removal: lead concentrations (μg/g) in exterior dust, mat dust, and floor dust; lead loading (μg/m^2) in exterior dust.

3.1.3 Characterize the Potential Recontamination of Remediated Soil

The second factor affecting the efficacy of soil removal is the extent to which the new soil may become recontaminated. One potential source of recontamination at Granite City is exterior residential lead paint. The study also considered the possibility that the fugitive lead dust spread through town by trucks or transported from the Taracorp site by wind could recontaminate soil. To evaluate this issue, the study measured street dust lead concentrations, perimeter soil lead concentrations, and curb soil lead concentrations both before and after soil removal.

3.2 Determine the Accuracy of Paint Lead Concentration Values Reported in the Illinois Dept. of Public Health Study

Questions have been raised about the validity of the paint lead measurements reported in the Illinois Department of Health Granite City Study since Illinois DOH used an older generation Gamma-Tech XRF device to make these measurements. The University of Cincinnati study evaluated these measurements by comparing the Illinois DOH values to measurements made using a SciTec XRF measuring device. The SciTec model is a later generation XRF device than the Gamma Tech model,

although both the SciTec and Gamma Tech devices have been evaluated and approved for lead paint testing by the Department of Housing and Urban Development (HUD).

4 Study Protocol and Methodology

This section describes the protocol for the University of Cincinnati study of lead contamination in Granite City, Illinois. Section 4.1 describes sampling procedures for dust and soil, while Section 4.2 describes paint XRF sampling procedures. This section also details steps taken for QA/QC purposes.

4.1 Collection of Dust and Soil

This section describes the collection of interior surface dust, 30-day dustfall collection, collection of interior entry mat dust loading, alley dust sampling, exterior dust sampling, and soil collection.

4.1.1 Collection of Interior Surface Dust

Interior surface dust is collected by using a personal monitoring pump connected by Nalgene tubing to a three-piece air monitoring cassette with a 0.8 micron poly cellulose acetate filter. A collection nozzle is connected to the air monitoring cassette by means of a short piece of Nalgene tubing. The collection nozzle is a piece of acrylic plastic tubing crimped on one end to form an opening of approximately 1.3 by 0.1 cm. To facilitate the collection of interior dust samples, a template is used. The inside of the template measures 25 cm × 25 cm.

The interior dust sample will consist of a composite of at least three sub-samples taken from following areas in the residence:

1. An area adjacent to the main entrance;
2. A floor area in the room most utilized by the subject child;
3. A floor area in the subject child's bedroom. (If there are no children residing in the house, we collect this part of the composite sample from the bedroom of an adult).

Additional sub-samples may be added to the composite sample. These sub-samples will be taken from bedrooms occupied by additional subject children (*i.e.*, children less than 72 months of age).

The main entry sample is collected by placing the template on a carpeted surface immediately inside of the entry door. The preferred sampling surface for interior dust is a carpeted surface. If carpeting is not present in this area the most likely place to find an adequate surface dust loading is the area immediately adjacent to the main entry door.

The identification of sample sites from the most frequently occupied room and the child's bedroom is determined in part by the floor covering present in those rooms. If the floor is carpeted, an adequate sample can readily be collected from almost any pathway in the room. A pathway might consist of an area immediately inside of a doorway into the room, or an obvious pathway from one side of the room to the other. In rooms where there is no carpeting, the most likely place to find an adequate supply of surface dust is an area immediately adjacent to a wall. Very often, on floors with hard surfaces, dust will migrate to the edge of the room; therefore, that is the most likely place to collect the dust.

The dust sample is collected by placing the template on the identified sampling area. The pump is then turned on and a visual check is made to ensure that the flow rate is 2.5 liters per minute. The collection apparatus (acrylic nozzle connected to cassette) is held at about a 45 degree angle to the surface (floor) and moved from one side of the template area to the opposite. This sweeping motion in the same direction is repeated until the entire area has been "vacuumed" with the collection attachment (approximate time – 1 minute in each direction). The procedure is repeated in a direction 90 degrees from the initial direction. A third coverage of the area is then completed in the same direction as the initial coverage. The rate of movement from one side of the template to the other is approximately 1.5 to 2 seconds per stroke (the total time to sample the area within the template is approximately 3 minutes).

As each sub-sample is collected, its location is indicated on the floor plan that was completed earlier. Care is taken to note the total number of areas sampled. At the completion of the sample collection, the dust cassette is removed from the collection device and the end plugs are replaced. The dwelling ID number and the sample number are written on the side of the cassette with permanent ink.

The FORM 05 Interior Dust Sampling-Residential worksheet is completed at the time the dust sample is collected. The XRF testing is conducted in the rooms where interior surface dust samples are collected (see Section 4.2).

4.1.2 Dustfall Collection – 30 Days

Dustfall samples are collected in polypropylene containers that have snap-on lids. They are "Tupperware™" type containers. The dustfall containers are cleaned in a nitric acid bath, sealed, and not opened until placed at the residence. The lid, appropriate labeled, is retained by the sampling crew in a sealed zip-loc bag until the sample is retrieved. The container is placed outside of the tested house (for example, on the porch area) at a level far enough above the floor level to be out of the reach of children. It is also located in a relatively inconspicuous spot so that no one will interfere with it; finally, the container is placed so as not to be exposed to rain and other elements. The required sampling time is 30 days.

4.1.3 Interior Entry Mat Dust Loading

One entry mat is placed inside of the tested house at the front door or back door, depending on which entrance is used most frequently by the residents. Prior to placement, the mat is vacuumed for 6 minutes with a Hoover Brush Vac© with a beater bar. Initially, the mat must be vacuumed for approximately 6 minutes.

When placed at the residence, the mat is checked to ensure that it does not interfere with the opening and closing of the door. The residents are instructed not to clean the mat. The testing crew vacuums the mat using the Hoover vacuum with brush. Total testing time is 20 days. The mat is left in place for the residents to use after completion of the study.

4.1.4 Alley Dust

The fugitive dust samples from the alleys are taken from gravel using a brush or the vacuum without the brush attachment. Large pieces of rock and gravel are removed and discarded prior to collection of the sample. One sample is obtained behind each test house. The location of the sample is close to a walk, fence gate, or garage that provides access to the rear yard.

4.1.5 Exterior Dust

Two composite exterior dust samples are collected: an entry sample, and a street sample. The entry sample is a composite sample from two separate areas, if available. The two entry sub-samples are collected from the front and side or rear entrances to the residence. If an entry is never used, no sub-sample will be collected from that entrance.

The street composite sample consists of a sub-sample collected from the intersection of the driveway and the street curb and a sub-sample from the curb area closest to the sidewalk leading to the front entry of the residence. If there is no sidewalk leading from the street to the front door, the curb area to be sampled is the area immediately in front of the front entry to the residence, or alternatively, the curb area closest to the front door.

The entry dust sample is collected by first selecting an area within 6 feet of the entrance with the heaviest loading of dust near the door. The area with the heaviest loading is most commonly the intersection of the first porch step and the sidewalk. Once the heaviest loading has been identified, the template is placed over an area that includes that loading. The perimeter of a template (1 square foot, *i.e.*, a square area measuring 12 inches by 12 inches, or a rectangular area measuring 6 inches by 24 inches) is drawn on the surface using carpenter's chalk. The template is removed and the dust is loosened, if necessary, by means of a stiff bristled brush. Once the material is loosened, it is brushed into a pile within the defined area with a paint brush. This pile is then deposited in the appropriate sample bag, along with the brush, using a scoop. After the bulk of the material is collected in this fashion, a portable vacuum cleaner (Hoover vacuum with brush) is used to vacuum the area defined by the chalk lines.

The sample is collected by passing the vacuum head across the designated surface area from one side to the other at a rate of 3 to 4 seconds per pass. Repeated passes are made at the same rate until the entire area has been vacuumed once. A second collection is made over the same area in a direction 90 degrees to the initial direction. Again, each pass lasts from 3 to 4 seconds. A third collection is made in the same direction as the initial collection. Both sub-samples are collected in this fashion.

Once the surface dust is brushed into the sample collection bag, the interior of the vacuum cleaner (including the cleaner bowl and the motor assembly) is cleaned by utilizing several wet wipes. On a dry,

sunny day, spontaneous, natural evaporation removes the dampness remaining from wet wipe. On cool, cloudy days, paper towels may be used to dry the interior of the vacuum cleaner. Removing the moisture from the vacuum cleaner prevents dust from the next sample collection from adhering to the vacuum cleaner parts.

The final step in the collection of the exterior dust samples is the final check of the data entered on the sample collection sheets (FORM 08-Exterior Sampling-Residential). The monitoring team makes certain that all of the data has been entered onto the sheets. The vacuum and other equipment are then packed to be transported to the next sampling site.

4.1.6 Soil Collection

Soil samples are collected with a coring device. The device may be used in either of two ways. There is a "T" handle that can be attached to the top of the coring device that allows the operator to push the coring tool into the ground. The coring tool can be twisted as it is pushed into the ground to allow the cutting edge of the soil corer to cut through roots and packed earth. Alternatively, a hammer can be attached to the top of the coring tool. After the coring tool is placed on the ground where the sample is to be collected, the hammer is raided and allowed to fall while it is guided by the operator's hands.

1. At each residence occupied by a participating family, composite soil samples are collected from the four sides of the residence. Three sub-samples will be collected from each side where soil is present. The samples are collected at a distance of one (1) foot from th exterior wall of the residence. Spacing along a side of the residence may depend on the location of sidewalks, vegetation, or other obstacles. If there is a sidewalk along an entire side of a house, the sample is collected along the edge of the sidewalk. If a sidewalk, driveway, or patio is immediately adjacent to a house and extends more than 3 feet from the foundation, no sample is collected at that location.

2. Soil samples are collected from the curb area (the area between the street and sidewalk). Six (6) sub-samples are obtained to make one (1) composite soil sample.

3. Variation soil sample – From two residences, twelve (12) grab samples have been obtained from either the front or rear yard (depending on the shape and area of the tested yards). Each grab sample consists of two core samples collected along two parallel lines extending from the house property line. The two lines are located one foot apart and grab samples are collected approximately every 3 feet. The first grab sample is located one foot from the house.

The sampling tools are decontaminated between each type of soil sample and between tested yards by brushing and wet wipe cleaning using water and detergent solutions. Samples are placed in double 6 mil plastic bags. All samples are labeled with the dwelling ID number using waterproof, permanent ink.

4.1.7 Summary of QA/QC Precautions

A subset of houses in the sample were identified for QA/QC control purposes. At each of these dwellings, the following QA/QC protocol was executed:

- Dust collection (Section 4.1.5): One (1) wet wipe sample is obtained after each decontamination of the vacuum as a QA/QC sample. Duplicate samples are obtained for selected houses (10 samples were initially planned based on the assumption that 50 dwellings would be surveyed). The dwellings selected as "QC homes" are chosen randomly; at these dwellings, co-located samples of all types are obtained. The lead levels in these co-located samples can be compared to assess sampling reliability.

- Soil collection (Section 4.1.6): As noted in Section 4.1.6, the sampling tools are decontaminated between each type of soil sample and between tested yards by brushing and wet wipe cleaning using water and detergent solutions. At the designated QA/QC residences, one (1) wet wipe sample has been obtained after decontamination of the coring device for QA/QC purposes.

In addition to the above QA/QC procedures, the following components are sampled *via* a 60 second measurement for QA/QC purposes:

- Three components on the exterior of the house. Possible options include, but are not limited to: exterior wall or siding, exterior porch ceiling, porch railing, exterior door, exterior window casing or sill, *etc.*

- Two components in the most frequently used entry room or foyer, *i.e.*, the wall, and the trim with the greatest surface area in the room. Some possible options for the trim include but are not limited to: door casing, window casing, baseboard, other decorative trim, *etc.*

- Two components in the room most utilized by young children in the house, *i.e.*, a wall and the trim with the greatest surface area.

- Two components from the child's bedroom, *i.e.*, a wall, and the trim with the greatest surface area. If no young children reside in the residence, an adult's bedroom will be selected.

A total of nine samples plus a quality control sample, if necessary, will be taken at each address.

The following general procedures also help to ensure the quality of the data:

1. The sampling points are documented by area maps, photograph, and video;
2. All samples are kept in 6 mil plastic bags or in glass jars; and
3. The samples are submitted with chain of custody forms to the University of Cincinnati for analysis.
4. The ID system is based on the site maps and house number.

4.2 XRF Sampling Protocol

Testing of paint has been performed using the SciTec XRF spectrum analyzer. The X-ray fluorescence spectrum analyzer used during the exposure assessment is manufactured by SciTec Corporation, 20000 Logston Boulevard, Suite 125, Richland, Washington, 99352. The radioactive source is licensed in Missouri (#RM-140).

The SciTec XRF spectrum analyzer is equipped with a Cobalt 57 radioactive source. This source has a half-life of 273 days. As time passes, the excitation, or rate of X-ray emission, from the Cobalt 57 source decreases. As the Cobalt 57 excitation source loses strength, the measurement time is automatically increased.

4.2.1 Method of Operation

The SciTec XRF spectrum analyzer is capable of taking three types of measurements:

- 15-second screen with an uncertainty of ± 0.6 mg Pb/cm^2;
- 60-second test with an uncertainty of ± 0.3 mg Pb/cm^2; and
- 240-second confirmation with an uncertainty of ± 0.15 mg Pb/cm^2.

The uncertainty decreases as the quantity of radiation counts received by the spectrum analyzer increases. The actual time of these measurements varies with the strength of the radioactive source.

The inconclusive range for each type of measurement, relative to 1.0 mg lead per square cm, is presented in Table 4.2-1.

Table 4.2-1
XRF Measurement Ranges

Type of measurement	Inconclusive Range
screen (15 seconds) uncertainty ± 0.6 mg Pb/cm^2	0.4 to 1.6 Pb/cm^2
test (60 seconds) uncertainty ± 0.3 mg Pb/cm^2	0.7 to 1.3 mg Pb/cm^2
Confirmation (240 seconds) ± 0.15 mg Pb/cm^2;	0.85 to 1.15 mg Pb/cm^2

If a measurement fall within the inconclusive range, the true lead concentration may actually be above or below 1.0 mg Pb per square cm.

The information generated by the SciTec XRF spectrum analyzer is stored in the XRF's memory and later downloaded to disk. All data collected for this inspection, including the spectrum for each sample, is retained.

4.2.2 Quality Assurance / Quality Control

The QA/QC program for the XRF spectrum analyzer ensures that accurate data are collected and a focused risk assessment is performed. These goals are accomplished through instrument calibration and duplicate sampling. Instrument calibration of the SciTec XRF spectrum analyzer is performed by both the manufacturer and the operator.

The XRF unity corrects each measurement for the particular substrate to which the paint is adhered. The manufacturer's calibration involves measurement of lead films of known concentration placed on many different types of building material substrates. The results of these tests are incorporated into a mathematical function that is a component of the XRF on-board computer's software.

The reference lead-based paint film used during the manufacturer's calibration is prepared by the National Institute of Standards and Technology (NIST) for HUD. Three lead concentrations are used: 0.6, 1.5, and 3.0 mg Pb per square cm.

In addition to the calibration performed by SciTec, the instrument will be calibrated daily by REACT against a lead painted calibration block. These calibrations are not accuracy checks, but rather checks to determine if the instrument is operating within the parameters set during manufacture. The calibration block, which is provided by SciTec, is coated with paint containing 1.1. mg Pb per square cm, and is measured by attaching it to the face of the XRF unit.

At the beginning of each lead paint inspection shift, a series of five test measurements on the calibration check standard will be made by REACT. If the average of these five test measurements does not fall within ± 0.7 mg Pb/cm^2 of the value reported by SciTec, another set of five readings will be taken. At this point, all ten measurements will be averaged and compared to the calibration block lead level of 1.1 mg Pb per square cm. If the averaged calibrations did not fall within 0.7 mg Pb/cm^2 of the true value, SciTec will be notified. The results of the start-up calibration will be plotted daily to determine if a trend representing bias or drift is present.

In addition to start-up calibration, the unit was checked against the standard every two hours. To assure legal defensibility and testing integrity, all calibration checks are documented and stored with inspection data in REACTs archives.

While instrument calibration assures that the XRF is operating to manufacturer's parameters, duplicate sampling establishes the accuracy of the data. Duplicate samples for 5% of the total data have been collected. Every twentieth sample has been taken twice, and the results compared. The difference in value between the two samples in each pair and the duplicate QA/QC samples are documented.

QA/QC results appear in Appendix A to this report.

5 Study Results

5.1 Lead Exposure Risk Reduction Following Soil Removal

This section summarizes study results that address the objectives outlined in Section 3.1 of this report.

5.1.1 Alternative Lead Sources Contaminate Interior Housedust

Data collected in Granite City by the University of Cincinnati identify two sources, in addition to soil, that contaminate interior housedust: lead-based residential paint, and street dust transported from the Taracorp site by either wind action or by trucks traveling from the site. Both of these sources must be considered as potentially important because the lead concentrations in both residential paint and in housedust are so high, as indicated in Table 5-1. One of these sources – lead paint – has far higher lead concentrations than soil samples taken from Granite City.

Table 5-1[a]
Lead Concentrations in Perimeter Soil Lead, Residential Lead Paint, and in Street Dust, in Unremediated Houses

		Lead Concentration Statistics (µg/g)			
Medium	**N**	**Average**	**Minimum**	**Maximum**	**Std. Deviation**
Perimeter Soil	26	2,588	298	14,238	3,024
Street Dust	25	580	179	2,463	462
Paint	12	43,933	178	157,000	52,054

Note:

(a) These statistics are calculated from the unremediated houses in the 1994 University of Cincinnati data set.

Paint lead can also be reported in terms of lead loading (mg lead per cm^2 paint). Much of the exterior residential lead paint measurements recorded in Granite City reveal loadings on the order of 10 to 30 mg of lead per cm^2 paint. That is, each square centimeter of exterior lead paint can contain on the order of tens of thousands of µg of lead. The complete data set from which the lead paint summary statistics in Table 5-1 have been calculated appears in Appendix B to this report.

Additional data collected from homes far from the Taracorp site (outside EPA's proposed area of remediation) further supports the hypothesis that exterior lead paint is a major source of lead contamination. The distance of these homes from the Taracorp site is sufficiently large to ensure that both past and current lead contamination from the site have had only a limited impact on soil lead concentrations. A comparison of soil lead levels near these houses to soil lead levels at the curb in front of these houses appears in Table 5-2.

Table 5-2[a]
Soil Lead Levels at the Drip line and at the Curb for Houses Far from the Taracorp Site

Location	Distance from site entrance (miles)	Soil lead concentration near house (μg/g)	Soil lead concentration near curb (μg/g)	Ratio of perimeter to cur[a]
2129 Grand	0.58	1757	526	3.340304
2146 Delmar	0.56	2729	288	9.475694
2142 State	0.56	1879	571	3.290718
2158 State	0.56	400	420	0.952381
2124 Edison	0.54	1513	189	8.005291
2128 Edison	0.54	650	148	4.391892

Note:

(a) This table includes all the unremediated houses at least 0.5 miles from the site entrance in the 1994 University of Cincinnati data set.

The fact that soil lead concentrations near these dwellings are much higher than lead concentrations at the curb indicates paint on the dwellings may be contaminating nearby soil (alternatively, these elevated le may reflect the impact of contaminated rain water running off the roofs of these dwellings).

Street dust lead concentrations are also very high in Granite City, suggesting that this medium may serve as an important interior dust contamination source if it is tracked into or blown into dwellings (see Appendix B, Table B-2 – Lead Concentrations and loadings for street dust samples collected in August, 1995). Moreover, these concentrations tend to be inversely proportional to the distance from the Taracorp site. Table 5-3 summarizes the lead concentration measurements recorded in Granite City.

Table 5-3[a]
Street Dust Lead Concentrations and Loadings in Granite City and Distance to the Taracorp Site

Location	Distance from site entrance (miles)	Concentration of lead in street dust (μg/g)	Lead Loadings in Street Dust (μg / m^2)
1429 Grand	0.3	443	1824
1436 Grand	0.3	1045	1,320
1431 Grand	0.3	665	168
1440 Grand	0.3	675	976
1438 Grand	0.3	1102	312
1437 Grand	0.3	416	184
1447 Grand	0.3	705	176
1415 Grand	0.32	565	1,104
1412 Grand	0.32	659	536
1418 Grand	0.32	334	736
1424 Grand	0.32	469	240
1413 Grand	0.32	608	6,560
1425 Grand	0.32	681	1,176
1417 Grand	0.32	606	NA
1441 Madison	0.32	NA	672
1400 State	0.32	556	66,000
1425 Madison	0.34	183	2,912
1439 Madison	0.34	216	1,536
1433 Madison	0.34	179	2,280
2030 Benton	0.44	2463	240
2124 Edison	0.54	320	536
2128 Edison	0.54	319	1,104
2146 Delmar	0.56	217	816
2142 State	0.56	521	992
2158 State	0.56	318	2,744
2129 Grand	0.58	228	3,080

Note:

(a) This table includes all of the unremediated houses in the 1994 University of Cincinnati data set.

Regressing these concentrations against distance yields a negative coefficient (a negative slope of 691 ppm lead in street dust per mile from smelter), verifying that street dust lead concentrations decrease with distance from the Taracorp site and indicating that the site is a continuing source of lead exposure for Granite City residents.

The data collected in Granite City were used to construct a Pathway Exposure that describes the pathways by which lead travels from one medium to another. The Granite City Pathway Exposure Model appears in Figure 5-1. Each pathway described in the model is quantified by a correlation coefficient and

an associated p-value, which appears in parentheses. Similar path models have been used to quantify the influence of environmental lead sources on childhood blood lead levels, and many of these models have appeared in the peer-reviewed literature (Bornschein *et al.*, 1986; Bornschein *et al.*, 1988).

5.1.2 The Short-Term Effectiveness of Soil Remediation on Lead Exposure as Reflected by Housedust Levels

As noted in Section 3, ingestion of interior housedust is an important pathway by which children are exposed to lead. We therefore have investigated pre- and post- soil removal dust lead concentrations. As of this time, data are available for only a limited number of dwellings, making it not possible to conduct a conclusive statistical analysis of this issue. Instead, Table 5-4 summarizes the available data.

Table 5-4[a]
Pre- and Post- Soil Removal Interior Dust Lead Concentrations (μg/g)

Location	Pre-remediation (1994)	Post-remediation (1995)	Difference (post- minus pre-remediation)
1412 Grand St.	608	652	-44
1415 Grand St.	1070	303	767
1418 Grand St.	109	522	-413
1424 Grand St.	462	782	-320
1431 Grand St.	1094	959	135

Notes:

(a) These are the only houses for which pre- and post-remediation data are available in the 1994 and 19' University of Cincinnati data sets.

Note that in the majority of cases, post-remediation dust lead concentrations are higher than pre-remediation concentrations. These findings may reflect the continuing contribution of interior paint to the interior dust lead levels. Several studies have demonstrated that interior dust lead is very difficult to remove.

5.1.3 Recontamination of Remediated Soil by Remaining, Non-Abated Lead Sources

The concentration of lead in exterior lead paint is much higher than typical lead concentrations in even unremediated soil in Granite City. Dust lead levels are also high. Table 5-3 in Section 5.1.1 summarizes some of the street dust lead concentration data collected as part of the University of Cincinnati

Study. We note that street dust lead concentrations are higher (500 to 1,000 μg/g) at locations near the Taracorp site. More disturbing is the very high lead loading (mg lead per square foot) in street dust. These levels are several orders of magnitude greater than permissible in interior housedust (0.1 mg / square foot).

Figure 5-2 illustrates the high levels of lead in exterior residential paint compared to residential soil. This Figure shows 2 vials: the left vial contains paint chips from Granite City, while the right vial contains soil from Granite City. Although the left vial contains only a few chips of paint and the right vial is virtually full of soil, the vials contain the same amount of lead. This comparison shows that a limited degree of lead paint contamination can substantially elevate the concentration of lead. Photographs of dwellings in Granite City (Figure 5-3) demonstrate that in many cases, exterior paint has deteriorated, making it available to recontaminate clean soil after remediation.

Finally, post-remediation soil lead concentration measurements recorded 1 year and 2 years after removal of contaminated soil indicate that many properties still have lead concentrations in composite soil samples that exceed 500 μg/g (for example, of the 38 perimeter soil samples, 9, or approximately 24%, had lead levels exceeding 500 μg/g when resampled after soil abatement; mid-yard lead levels were considerably lower, with 3, or approximately 8%, exceeding 500 μg/g when resampled). Hence, in the presence of elevated levels of lead in paint and the Taracorp pile, government sponsored remediation is proving ineffective in many cases in reaching its stated goal of residential soils of less than 500 μg/g. Table 5-5 summarizes the soil lead concentration results.

Table 5-5[a]
Post-Remediation Soil Lead Concentrations (μg/g):
1 year and 2 years after Soil Removal

	Time[b]	N	Mean	SD	Min	Max
Perimeter Soil	1 year	17	676	1,048	38	4,154
	2 years	21	339	823	46	3,845
Mid-yard Soil	1 year	17	194	436	23	1,770
	2 years	21	277	915	27	4,257

Notes:

(a) *These statistics are calculated from the 1995 University of Cincinnati data set.*

(b) *The 1-year and 2-year houses are not the same houses. There are a total of 38 houses; 17 of these had been remediated 1 year ago, and 21 had been remediated 2 years ago.*

5.2 The Illinois Department of Public Health Paint Lead Measurements are Valid

The Princeton Gamma-Tech XRF paint lead readings, which indicated markedly elevated levels of lead in paint, have been validated using the SciTec XRF device and by atomic absorption analysis of paint chips.

6 Discussion and Conclusions

6.1 Soil Removal in the Absence of Other Interventions that Address Other Lead Sources Does not Reduce Lead Exposure

EPA has justified its decision to address lead exposure in Granite City by removing contaminated residential soil on the basis of predictions made by the Agency's Integrated Exposure Uptake Biokinetic (IEUBK) model. For example, EPA states that "... the IEUBK model can be used at this [the NL Taracorp] site, with appropriate site-specific input parameters appearing not much different than standard model parameters" (Marcus, 1994, p 58). However, the IEUBK model, as used by EPA, assumes that 70% of the lead in interior housedust derives from soil tracked in from the outside (US EPA, 1994). As noted in Appendix C, empirical measurements of this transfer coefficient have yielded considerably lower values. Moreover, the model makes no allowances for lead sources that may continue to contaminate exterior soil. In other words, the assumptions underlying the model imply that soil is the main source of lead in interior housedust, and moreover, that removal of the lead in exterior soil will be permanent and that such removal will substantially decrease interior dust lead concentrations. Applying the model to the Granite City population suggests that soil removal will substantially decrease childhood lead exposure since the model assumes that children ingest between 85 and 135 mg of soil and interior housedust each day (US EPA, 1994). Both the University of Cincinnati Study at Granite City, and other studies, do not support EPA's plans to remove lead-contaminated residential soil before addressing other sources of lead contamination.

Section 5.1 documents three sets of findings from the University of Cincinnati study that cast doubt on the efficacy of soil removal as a means to reduce lead exposure in Granite City. Section 5.1.1 identifies two lead contamination sources – residential lead paint, and street dust apparently transported from the Taracorp site – that appear to be important. In the case of residential paint, lead concentrations often far exceed the concentrations found in soil. The Path Model, which reflects the data collected in Granite City (see Figure 5-1), illustrates the importance of these sources and pathways. EPA's IEUBK model, in contrast, does not adequately characterize the flow of lead between various source pools, including sources contributing to lead in interior dust.

Dr. R. Kimbrough's study of Granite City (Kimbrough *et al.*, 1995) also suggests that paint, especially when it is in poor condition, is an important source of lead contamination. The results in the Kimbrough study showed that "lead in paint together with the condition of the house were the main contributors to the dust lead variance (26%) with soil lead accounting for an additional 6%." In other words, residential lead paint is approximately four times more important than soil lead concentrations in explaining the variance in dust lead concentrations in Granite City.

Other studies also point to the potential importance of lead paint relative to lead in soil, especially when the lead concentration in that paint is high and the paint is in poor condition. For example, Don Ryan, Director of the Alliance to End Childhood Lead Poisoning wrote in a letter to EPA/ECAO (Ryan, 1994) that "[EPA's] three cities studies appear to confirm our belief that the most intensive exposures come from lead-based paint and interior dust and that the benefits of soil abatement as a stand-alone strategy are modest in most cases." In fact, as noted below, only in Boston did investigators observe statistically significant changes in blood lead levels after soil abatement was conducted (US EPA, 1995). However, soil lead concentrations were considerably higher in Boston – on the order of 2,000 μg/g (Aschengrau, 1994) – than they were in either Baltimore or Cincinnati. These findings suggest that soil remediation, if effective at all, is effective only when soil lead levels are substantially elevated.

Data from the University of Cincinnati study also indicate that lead transported from the Taracorp site continues to be an important contamination source. Street dust lead levels remain high more than a decade after lead smelting operations ceased at the Taracorp site (see Appendix B, Table B-2, page 6 Lead Concentrations and loadings for street dust samples collected in August, 1995). Since streets are cleaned often (by either the city or by rain), the lead levels now observed cannot be the result of historic smelting operations. Two additional points should be noted. First, the lead loadings listed in Appendix B, page 6 are extremely high. Note that the units reported are mg/m^2, so that the highest lead loadings reported are on the order of 5 g/m^2. Second, the data listed in Appendix B, page 6 reveal that the lead loadings adjacent to the Taracorp site are higher (average = 2,737 mg/m^2) than those that were measured at other locations (average = 1,168 mg/m^2), again supporting the hypothesis that the Taracorp site continues to act as a source of lead contamination for Granite City. The path model based on the University of Cincinnati data, along with data indicating that street dust lead levels decline with distance from the Taracorp site, further support the possibility that wind action or trucks traveling from the site spread contaminated dust, dust that is likely to originate within the site and is perhaps attributable to the lead slag

piles within the site. The importance of this source again indicates that remediation of residential soil alone will not address substantial contributors to environmental lead contamination in Granite City.

The second finding in Section 5.1 that casts doubt on the efficacy of soil removal on lead exposure is documented in Section 5.1.2. That section demonstrates that dust lead levels do not consistently decrease after remediation of soil; in some cases, dust lead levels increase. This finding may reflect the relative importance of other lead contamination sources (described above). Alternatively, it may reflect inadequate remediation practices in Granite City. For example, after removing soil from contaminated yards, abatement contractors do not always cover the abated area during the interval prior to replacing the removed soil with clean fill. This practice may disturb and uncover contaminated soil, making it more available to contaminate the surrounding environment as the result of wind action. In other cases, abatement contractors have failed to completely cover with plastic contaminated soil that is removed from yards to prevent it from being spread. These inadequate remediation practices may disturb and redistribute lead in the soil, contaminating both exterior and interior housedust.

The final finding in Section 5.1 casting doubt on the efficacy of soil removal is the potential for recontamination of soil after abatement (Section 5.1.3). Specifically, paint has much higher lead concentrations than does soil, and hence can potentially recontaminate clean soil. Street dust lead levels are also elevated. Second, empirical measurements of soil lead concentrations recorded during the first and second year after soil removal (Table 5-5) verify that soil lead concentrations remain elevated (more than 500 μg/g) in many yards.

The findings from the University of Cincinnati study support the claim that remediating soil prior to addressing other contamination sources will not effectively decrease lead exposure among the Granite City population. As conducted, soil remediation may increase lead exposure. First, as noted above, soil remediation can increase dust lead concentrations by releasing lead from the soil. In addition, large-scale, highly visible remediation efforts might give the Granite City community a false sense of security, suggesting to them that the lead problem has been addressed, when in reality the situation persists. It is conceivable that some parents may relax their vigilance after remediation of yard soil, putting their children at even greater risk of exposure to lead in both external dust and interior housedust.

Remediation strategies that address multiple media at other sites confirm that focusing on soil alone at Granite City is ill-advised. Aschengrau *et al.* (1994) investigated the efficacy of soil abatement, along with soil, dust, and paint abatement, as part of the EPA's "Three-City Study," carried out in the early 1990's. Although soil abatement alone decreased blood lead levels by 1 to 2 μg/dL in the Boston population, Aschengrau *et al.* noted that "Soil abatement was not effective among children with persistently elevated interior floor dust lead loading levels" (p 146) – a scenario comparable to Granite City. The EPA's integrated draft report for the Agency's Urban Soil Lead Abatement Project notes that abatement of soil will not result in a statistically significant decline in blood lead levels unless there is "(a) a notably elevated starting soil lead concentration (*e.g.*, in excess of 1,000 to 2,000 μg/g); [and] (b) a marked reduction of more than 1,000 μg/g in soil lead consequent to soil abatement..." (U.S. EPA, 1995, p 6-4). EPA also emphasizes the importance of addressing multiple sources of lead contamination. For examp' the Agency states that, "The maximum reduction in lead exposure will not be achieved unless both paint and soil abatement are implemented' (p 6-11). The Agency adds that, "At a minimum, when implemented, both soil abatement and interior dust removal should be performed to be fully effective" (p 6-12).

EPA's proposed remediation plan for the Silver Bow Creek/Butte Area Site (US EPA Region VIII, 1994) also addressed the multi-media nature that often characterizes lead contamination. EPA's Preferred Response Action included the following tasks (p 4):

- "Cleanup interior and exterior lead paint by replacement, encapsulation, paint removal, and/or house siding as necessary."
- "Remove indoor dust contaminated with lead by cleaning: heating ducts, interior surfaces, and attics, and replacing: insulation, cloth furniture, and carpeting."
- "Continue blood-lead testing of young children, lead education and awareness activities"

Commenting on the Butte site for EPA, Griffin *et al.* (Griffin *et al.*, 1993) also point out the importance of addressing lead-based paint when attempting to reduce lead contaminated housedust. They state that, "The primary source of lead exposure appeared to be lead-contaminated housedust which was contributed to indirectly by soil lead and deteriorated lead-based paint."

6.2 Paint Lead Concentrations Reported by the Illinois Department of Public Health are Valid

Results from the University of Cincinnati study show that the Illinois Department of Public Health correctly identified the number of dwellings with elevated paint lead concentrations. Like the results of the Illinois Department of Public Health, sampling conducted using the SciTec XRF device revealed that only a small fraction of dwellings in Granite City have exteriors free of lead paint. The SciTec device identified only two houses out of 35 (6%) that were lead paint free. These results were further confirmed using wet chemical analysis of paint chip samples from dwellings in Granite City.

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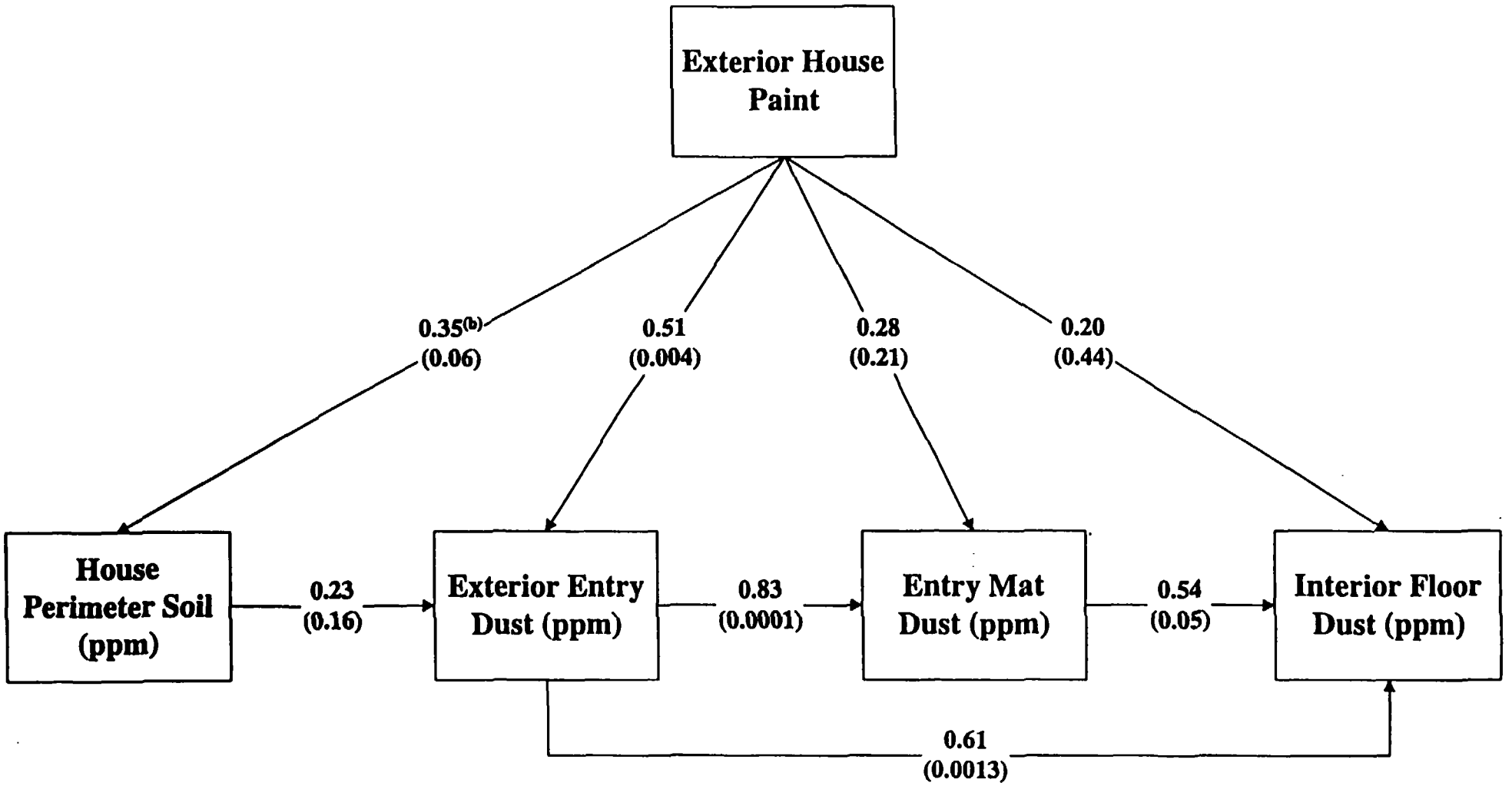
Figure 5-2

Illustration of relative concentrations of lead in soil and paint in Granite City

To be provided

Figure 5-1
Granite City Path Model[a]
N = 25 - 38



Notes:

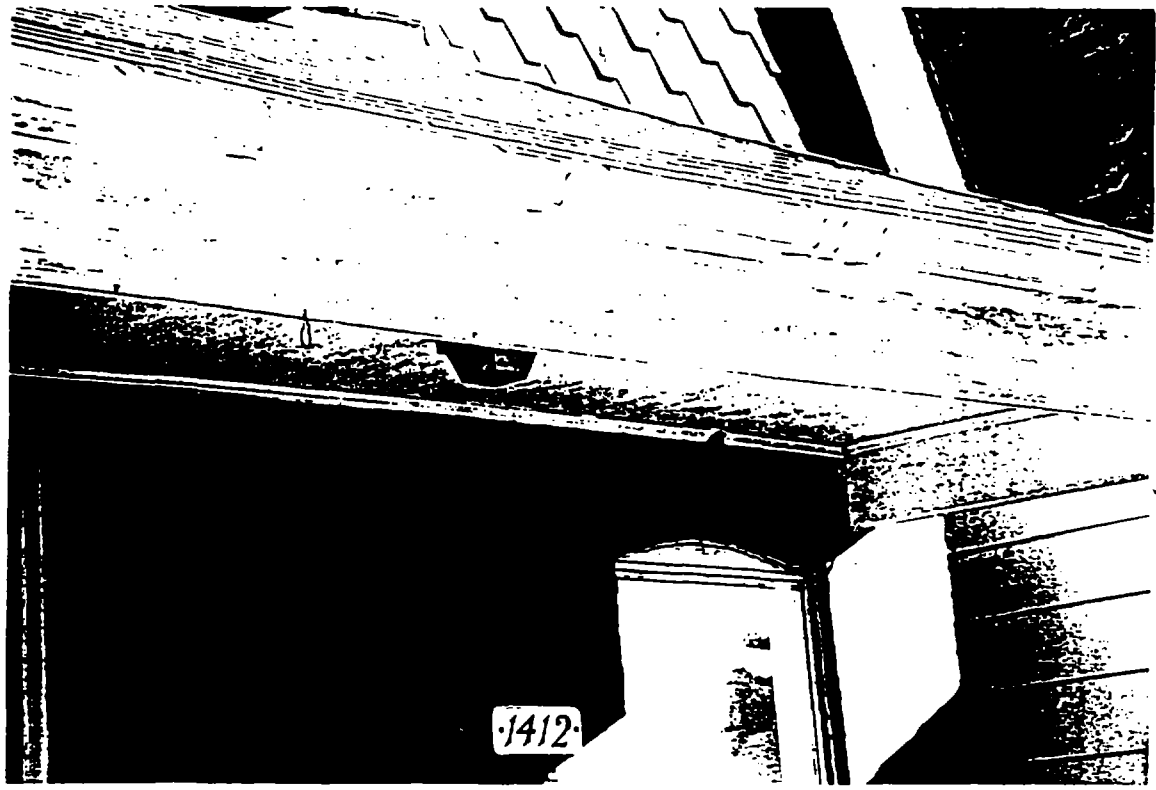
(a) Based on 1995 data from the University of Cincinnati Study.
(b) Values are correlation coeficients; values in parantheses are p-values.

Figure 5-2

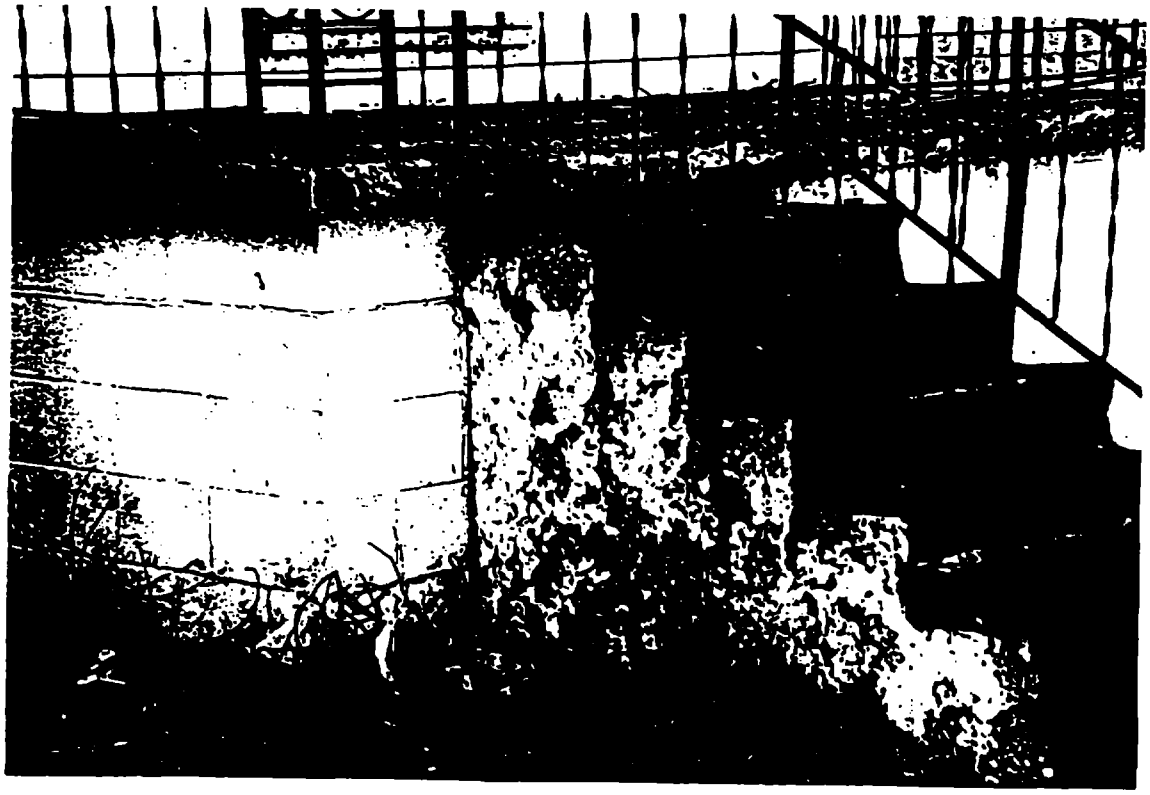
Illustration of relative concentrations of lead in soil and paint in Granite City

To be provided

Figure 5-3
Deteriorated Exterior Paint on Dwellings in Granite City



1412 Grand



1429 Grand

Figure 5-3 (Cont)
Deteriorated Exterior Paint on Dwellings in Granite City

1438 Grand

Appendix A
QA/QC Results

GRANITE CITY, ILLINOIS

ENVIRONMENTAL SAMPLES

FIELD AND LABORATORY QUALITY CONTROL RESULTS

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April 24, 1996

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Introduction

Granite City, Illinois Field and Laboratory Quality Control Results

The quality of sample collection and analysis can be monitored by evaluation specific quality control procedures implemented as a component of a project's sampling and analytical plans. In the Granite City, Illinois Lead Exposure Study various types of quality control measures were utilized to assess overall quality including the accuracy and precision of sampling and daily laboratory activities. The following report summarizes the results of the quality control data generated for the study samples. Attachment A contains listings of the actual Q.C. samples.

Soil

Soil samples were collected and shipped to the Hematology and Environmental (H&E) laboratories at the University of Cincinnati for analysis. Samples were dried and sieved to a particle size of <250 microns and analyzed by a laboratory XRF unit, the KEVEX Analyst 770 Delta Analyzer. Collection of co-located or duplicate samples was part of the study's field sampling design (Table 1). Variation in these values reflect all sources of variance, including environmental heterogeneity, sample collection, sample preparation (sieving, splitting, and weighing) and data analysis. In addition, field control samples were inserted into the study samples prior to delivery to the lab (Table 2).

Analysis by XRF is a non-destructive method. Two bench controls are run with every set of 14 samples analyzed. Limits of ± two standard deviations were established for these controls; and, if the concentration of one or more of the controls fell outside of the established limits, the entire run was reanalyzed. The limits for these control samples were:

LEAD (low)	162 - 192 ppm
LEAD (high)	1051 - 1151 ppm

Information on the controls analyzed within the runs of study samples is presented in Table 3

TABLE 1

SOIL Pb RESULTS FOR CO-LOCATED SAMPLES

INITIAL SAMPLE (PPM)	REPEAT SAMPLE (PPM)
28	31
31	31
60	29
71	88
80	62
342	276
670	575
767	1703

TABLE 2

FIELD (BLIND) Q.C. SAMPLES

		SOIL (ppm)	
	Target	303	1633
RESULTS:	N	5	5
	MEAN	296	1524
	S.D.	9.4	31
	%C.V.	3%	2%
	MINIMUM	286	1486
	MAXIMUM	310	1572
	RANGE	24	86

TABLE 3

SOIL Pb XRF
CALIBRATION CHECK SAMPLES

	ASSIGNED CONCENTRATION	
	177 ± 15 ppm	1101 ± 50 ppm
N	7	7
MEAN	173.3	1052.1
S.D.	4.3	50.3
% C.V.	2.5%	4.8%
MINIMUM	167	994
MAXIMUM	181	1107
RANGE	14	113

EXTERIOR MAT INTERIOR DUST AND DUST FALL

Dust samples were collected and then shipped to the University of Cincinnati H & E labs for analysis. Since almost all of the mat and exterior dust samples weighed less than 2 grams (the minimum sample weight required for XRF analysis), the samples were digested and analyzed by flame-atomic absorption spectroscopy (FAAS). Interior dust samples were obtained by using a micro vacuum (2L/min. personal air sampler) with a cassette attached to collect the sample. The sample was extracted from the cassette by rinsing with distilled deionized water, collecting the rinsate, and evaporating to dryness. This sample was then weighed, digested and analyzed by FAAS. Because of the additional steps in this process, reagent blanks and method samples were acceptable based upon quality control limits and laboratory criteria for acceptability.

Collection of co-located or duplicate samples was part of the study's field sampling design (Table 5). In addition, field control samples were inserted into the study sample stream prior to delivery to the lab (Table 6).

TABLE 4

DUST Pb LABORATORY QUALITY CONTROL SAMPLES

	CONTROL AND KNOWN CONCENTRATION						
	Regent Blank (μg)	Method Blank (μg)	NIST-E #1646 28±4 (ppm)	NIST-U #1648 6550±160 (ppm)	NIST-BRS #2704 161±34 (ppm)	R-HIGH (BULK) 2816±283 (ppm)	R-LOW (BULK) 488±67 (ppm)
N	31	5	11	20	15	4	5
MEAN	0.15	0.26	23.6	6136	150	2685	471
S.D.	0.17	0.36	2.6	207	3.4	75	28
%C.V.	114%	138%	11%	3%	2%	3%	6%
MINIMUM	<0.1	<0.1	20.3	5885	142	2618	440
MAXIMUM	0.4	0.9	30.8	6844	155	2770	517
RANGE	0.3	0.8	10.5	959	13	152	77

TABLE 5

DUST Pb RESULTS FOR CO-LOCATED SAMPLES

	INITIAL SAMPLE (ppm)	REPEAT SAMPLE (ppm)
INTERIOR DUST	303	264
	943	976
	959	863
EXTERIOR DUST	276	377
	2209	2329
	2479	1317

FIELD (BLIND) Q.C. SAMPLES INTERIOR DUST (ppm)		
TARGET		161
RESULTS:	N	4
	MEAN	142.8
	S.D.	10.7
	%C.V.	7%
	MINIMUM	132.7
	MAXIMUM	157.6
	RANGE	24.9

PAINT

Paint samples were collected and shipped to the UCH&E labs for analysis. In the lab, samples were ground, digested, and analyzed by FAAS. The method detection limit was 10 µg Pb. The sample runs consisted of blanks and NIST lead-based paint SRMS. All runs were acceptable and within laboratory quality control criteria. The results of the paint Q.C. are listed in Table 7.

TABLE 7

PAINT Pb LABORATORY QUALITY CONTROL SAMPLES

CONCENTRATION	Reagent Blank (µg)	Powdered Pb based Paint #1579A 119,950±310 (ppm)	CONTROL AND KNOWN Powdered Pb based Paint #2582 208.8±4.9 (ppm)
N	8	8	2
MEAN	<10*	119,854	219
S.D.	0	3885	55
%C.V	0	3%	25%
MINIMUM	<10	115,813	180
MAXIMUM	50	125,638	258
RANGE	-	9825	78

**Notes: all results <10, except one value = 50 ppm*

Attachment A

Data Listing for all Q.C. Samples

List of Tables

Table 1	Soil
Table 2	Exterior Dust
Table 3	Interior Dust
Table 4	Dustfall Dust
Table 5	Entry Mat Dust
Table 6	Paint
Table 7	Co-located Samples

TABLE 1
Granite City Soil Q.C.

Reference LO 177 (ppm)	Reference HI 1101 (ppm)
167	1107
175	1105
174	1099
173	994
181	999
173	1034
170	1027

TABLE 2
Granite City Exterior Dust Q.C.

HI STD 2816 PPM	LO STD 488 PPM	NBSE 27.1 PPM	BRS 161 PPM	NBSU 6550 PPM	MH SOIL 5532 PPM	MM SOIL 1162 PPM	REAGENT BLANK	DUPLICATE	DUPLICATE	DUP. DIFF	% RECOVERY
2770.1	516.6	23.3	151.5	6066.7	5464.0	1173.0	<0.1	44.0	44.0	0.0	103.0
		22.8	154.7	6105.5	5534.0	1156.0	<0.1	61.0	61.0	0.0	102.0
		22.7	149.5	5885.0			<0.1	61.0	61.0	0.0	102.0
			149.5	6007.8			<0.1	50.0	50.0	0.0	105.0
			147.8	6105.5			<0.1	66.0	64.0	2.0	102.0
			149.4				<0.1	39.0	39.0	0.0	101.0
			153.0				<0.1	50.0	50.0	0.0	
			148.1				<0.1	30.0	30.0	0.0	
			151.1				<0.1	73.0	73.0	0.0	
							<0.1	46.0	46.0	0.0	
							0.1				
							<0.1				
							<0.1				
							<0.1				
							0.3				
							0.2				

TABLE 3
Granite City Interior Dust Q.C.

HI STD 2816 ppm	LO STD 488 ppm	NBSE 27.1 ppm	BRS 161 ppm	NBSU 6550 ppm	REAGENT BLANK	METHOD BLANK	DUPLICATE	DUPLICATE	DUP. DIFF.	% RECOVERY
2772.3	474.4	30.8	155.2	6277.2	0.4	<0.1	27.0	27.0	0.0	105.0
	440.0	23.5	151.9	6376.2	0.2	<0.1	26.0	25.0	1.0	102.0
		24.4		6162.0	<0.1	<0.1	27.0	27.0	0.0	102.0
		23.1		6844.1	<0.1	0.9	25.0	24.0	1.0	105.0
		22.2		6140.4	<0.1	<0.1	486.0	486.0	0.0	100.0
		22.4		5911.7	<0.1					100.0
		23.6			0.1					99.0
		20.3			<0.1					102.0
					0.1					

TABLE 4
Granite City Dustfall Q.C.

HI STD 2816 ppm	LO STD (488 ppm)	REAGENT BLANK	DUPLICATE	DUPLICATE	DUP. DIFF.	% RECOVERY
2626.5	460.1	<0.1	54	55	0	101
2617.8	466.1	<0.1				

TABLE 5
Granite City Entry Mat Q.C.

BRS 161 ppm	NBSU (6550 ppm)	REAGENT BLANK	DUPLICATE	DUPLICATE	DUP. DIFF.	% RECOVERY
147.9	6210.7	<0.1	36	36	0	103
142.0	6213.8	<0.1	39	39	0	103
146.6	6103.2	<0.1	53	53	0	101
146.7	6142.6	<0.1				

TABLE 6
Granite City Paint Q.C.

LO Pb PAINT 208.8 ppm	HI Pb PAINT 119,950 ppm	REAGENT BLANK	DUPLICATE	DUPLICATE 14000	DUP. DIFF.	% RECOVERY
180	116,689	<10	15200		400	101
250	119,221	<10	58000	58000	0	100
	117,272	<10	70	70	0	97
	115,813	<10	310	310	0	101
	123,853	<10	60	60	0	103
	125,638	<10	420	420	0	97
	123,534	<10				
	116,809	50*				
		<10				

TABLE 7
Granite City Co-Located Sample Results

SOIL	SAMPLE 1
	28
	31
	60
	71
	80
	342
	670
	767
EXTERIOR DUST	SAMPLE 1
	276
	2209
	2479
INTERIOR DUST	
	303
	943
	959

Attachment B

Analytical Methods

N. Preparation - Surface Dust Samples
O. Preparation - Dust Fall Samples
P. Nitric Digestion of Interior Dust & Dustfall Samples for Lead
Q. Nitric Digestion of Soil & Exterior Dust Samples for Lead
R. Nitric/Peroxide Extraction for Paint Samples
W. The Determination of Lead in Environmental Samples
EE. XRF Analysis of Soil and Exterior Dust for Lead

N. Preparation - Surface Dust Samples

Preparation for Acid Digestion

1. Fill in Lab # numbers for 27 beakers in lab notebook starting with the next # number after the last # number from the previous batch of completed samples.

2. Mark and date 27 100 ml beakers that have been previously washed, rinsed, acid soaked for 4 hours and rinsed in D.I. H_20 with the 27 numbers from the lab notebook for that run of samples.

3. Place beakers in drier oven for 1 hour.

4. While beakers are in drier oven, pick out random # numbers from the 27 in that run to be used for 2 High or Low standards.

   1 NBS-E or NBS-U standards
   1 reagent BLANK = RB
   1 method BLANK = MB

   The standards will have numbers on the cassettes. Write this number next to the lab number you have selected for that standard.

   Next to the number for reagent BLANK write RB.
   Next to the number for method BLANK write MB.

5. Next fill in sample # numbers next to your 22 remaining lab numbers along with Family I.D. # numbers.

6. Move beakers from drier oven to cooling box with tongs for 1 hour. While beakers are in cooling box, line up sample cassettes on lab bench top next to hoods.

7. About 6" behind cassettes lay down a line of overlapping Kimwipes and place your numbered beakers on them upside down after weighing.

8. When beakers are ready to come out of cooling box, cover top of lab cart with Kimwipes. Calibrate balance just before weighing.

9. Remove 9 beakers from cooling box with tongs and place on the cart. Move carat to balance. Move beakers on to balance with tongs and record weight in log book. Be sure to match beaker number to lab number.

10. At this point you may remove the beakers from the balance by hand to the cart and bench top.

11. After 3 sets of 9 beakers have been weighed and placed upside down on clean Kimwipes next to sample cassettes. Double check to make sure numbered beakers are lined up in order to match numbers in log book.

12. Set up 27 watchglass covers on clean Kimwipes in front of cassettes. Fill 3 squirt bottles with D.I. H_20.

13. Move first beakers and first sample cassette to area where sample transfer will occur.

14. Using spatula carefully, pry top off of cassette. Tap sample into beaker.

15. Rinse inside of cassette top into beaker using rinse bottle with D.I. H_20. Next rinse inside of cassette and pour rinsings into beaker. Then pry the next ring off and, starting with the inside top of the ring, rinse into beaker. Next rinse out the inside of the cassette again. Remove top filter with tweezers and rinse both sides into beaker starting from back to front, then front to back. Next remove support pad and rinse the same as was done with the top filter. Next rinse the inside bottom of cassette into beaker and discard cassette in trash can. By rinsing from back to front, you will wash more sample out of filter.

16. Move beakers to back of lab batch and cover with watchglass. Move on to next sample.

17. When you come to empty cassette (method BLANK) treat the same as sample. When you come to 50 ml beaker (reagent BLANK), move the numbered beaker to your rinsing spot and fill it with 40 to 50 mls of D.I. H_20 from your bottle. DO NOT rinse 50 ml beaker into numbered beakers. IT IS ONLY A MARKER.

18. After all samples have been rinsed into the numbered beakers move them to drier oven at 105° C for Pbk or 95° C for As digestion.

19. After all samples have been placed into the frier oven, allow them to remain there overnight.

20. The first thing the next day move all samples into cooling box for 1 hour using tongs.

21. Cut 27 pieces of parafilm about 9 ½ mm x 9 ½ mm and place them on Kimwipes next to balance.

22. After beakers have been in cooling box for 1 hour, calibrate balance and remove with tongs 9 samples at a time to lab cart with top covered with bench top paper.

    Remove watchglasses by hand without touching beakers, then place beakers on balance with tongs and record weights in lab notebook. Double check to be sure you place the weight next to the proper lab number. At this point you may handle the beakers.

    Remove from balance and cover the top with parafilm, pulling the parafilm snug but not to snug as it may shrink and tear later on. Expose the sample to air. Move on to next sample.

23. After all the samples have been weighted and covered with parafilm, place them in box with sample sheet. Write date the samples were processed.

24. Next go to lab notebook and subtract empty beaker weight from (beakers sample weight) and enter difference in lab book.

Samples are now ready to be submitted to the Lab technician (Rose) for digestion.

O. Preparation - Dust Fall Samples

Preparation for Acid Digestion

1. Record lab # numbers for 29 beakers into lab notebook starting with the next # number from the previous batch of completed samples.

2. Mark and date 29-100 ml and 29-250 ml beakers that have been previously washed, rinsed, acid soaked for 4 hours and rinsed in D.I. H_20 with the 29 numbers from the lab notebook for that run of samples. (Refer to procedure for cleaning glassware).

3. Place beakers in drier oven for 1 hour, "only 100 ml beakers."

4. While beakers are in drier oven, pick random # numbers from the 29 that run to be used for 2 High or Low standards.

   1 NBS-E or NBS-U standard

   1 reagent BLANK

   1 METHOD BLANK

   Next to the number for reagent BLANK write RB

   Next to the number for method BLANK write MB

5. Next fill in the sample # numbers next to your 24 remaining lab numbers along with Family I.D. # numbers and area/Cm^2 in log book.

   Move beakers from drier over to cooling box with tongs for 1 hour.

6. Use new plastic containers to make up 1 High of 1 Low standards 2 NBS-E or 2 NBS-U, to do this weight out 50 mg on weighing paper and transfer into container. You must mark the lid with type of standard, weight and lab #. Be sure to enter weight and lab in log book.

7. Next mark sample containers with Lab # in order from your lab book. Next stack sample in order on lab bench with standards on blank in their proper order.

8. Using the lab notebook, march place samples and standards in order according to number. When you come to method BLANK, place on empty container in that space. When you come to the reagent blank, place a paper towel with Lab # and reagent blank written on it. Lay down a line of overlapping Kimwipes to place your number beakers on after weighing.

9. Cover the top of the lab cart with bench paper. Calibrate balance just before weighing.

10. Remove 9 beakers from the cooling box with tongs and place on the cart. Move cart to balance. move beakers on to balance with tongs and record weight in log book. Be sure to match beaker number to lab number.

11. At this point, you may remove the beakers from the balance by hand to place on the cart and bench top.

12. Dustfall samples are contained in plastic containers with lids.

13. Using clean forceps remove any obvious foreign objects from the dustfall container such as insect bodies, leaves, pins, etc.., and discard.

14. Using hot distilled/deionized water in a glass wash bottle, and by scraping with a rubber policeman, quantitatively transfer the dust fall samples by rinsing to a labeled, acid washed 250 ml beaker. Rinse the inside lid of the dustfall container also. If the dustfall container is very heavily loaded, an additional labeled 250 ml beaker may be used. When you come to reagent blank, fill beaker with 100 mls D.I. H_20 and cover.

15. Cover each sample with a watchglass supported by two glass hooks. Evaporate the dustfall rinsings to about 50 ml on a hot plate at about 200° C. If more than one beaker was used, amalgamate the rinsings.

16. Rinse the concentrate dustfall rinsings with hot distilled/deionized water and scrape into a tared, acid washed 100 ml beaker. Beaker tare weights will be taken on a calibrated 4-place analytical balance.

    BE SURE TO MATCH LAB # ON 250 ML BEAKER WITH THE SAME LAB 3 ON 100 ML BEAKER.

17. Transfer the covered sample beakers to a drying oven which has a maximum temperature of 105°C. Dry in the oven overnight.

18. Keep the samples covered. Place the samples in a desiccated cabinet to cool prior to weighing for one hour.

19. Obtain the gross weight of the dustfall sample plus beaker to obtain the total sample weight collected.

20. At this point, the samples should be covered with parafilm for storage prior to acid digestion.

P Nitric Digestion of Interior Dust & Dustfall Samples for Lead & Arsenic

1. The regents being used are 1M and 7M reagent nitric acid prepared with distilled deionized water.

1M = 64 ml HNO_3/1 liter D.D. H_2O (volumetric)

7M = 898 ml HNO_3/2 liter D.D. H_2O (volumetric)

Measure conc. acid in a graduated cylinder. Pour acid slowly into the volumetric half-filled with water, frequent swirling. Make up to volume.

Make up solution 1 day prior to use, to allow for cooling of acid, then bring back up to volume.

2. To each sample, add 25 ml of 7M HNO_3 using a repeater pipetter dispenser or acid buret. Wash down the sides of the beaker.

3. Cover each beaker with a ribbed watchglass, place samples on hot plate at 120° Centigrade for 2 hours. For arsenic samples stay at 100° Centigrade throughout procedure.

4. Remove the samples from the hot plate and cool in hood until they are at room temperature.

5. The entire filtration procedure should take place under the hood. Use a wash bottle filled with 1M HNO_3 for rinsing. Set up glass funnels over 100 ml pre-labeled beakers. In each funnel, place a folded whatman #54 filter paper. Before filtering, wet filter paper and rinse glassware with about 20-30 ml of 1M HNO_3. Discard waste rinse. To filter, decant the liquid from the sample first, then pour the solids onto the filter. Once this has drained, wash the beaker with 3 small (3 ml) portions of 1M HNO_3, adding each wash to the filter paper. Rinse the filter paper with 3 small (3 ml) portions of 1M HNO_3. After the filter paper is thoroughly drained it is discarded. Rinse the glass runnel with one small portion of 1M HNO_3.

6. Re-cover samples with watchglasses and place on a hot plate at 180° Centigrade to evaporate down to dryness. Remove samples just at dryness to avoid burning. For arsenic samples temp. is 100° Centigrade and can be left overnight to go down to dryness.

7. To re-dissolve lead, add - 3 ml of 1M HNO_3 (using Pasteur pipets), rinsing down sides of beakers.

8. Re-cover beakers with watchglasses and put on hot plate at 120° Centigrade for a few minutes (5-10 min.) to mildly heat, some of the 3 ml may evaporate.

9. Cool the samples to room temperature. Pour the remaining sample into a 10 ml labeled centrifuge tube. Rinse the beaker 3 times with 1M HNO_3 from a Pasteur pipette. Each rinsette should be about 1 ml. Bring sample up to volume, shake thoroughly.

10. Samples are then submitted to the A.A.S. lab for determination of lead or arsenic. Samples are now 6.4% nitric acid.

Q. NITRIC DIGESTION OF SOIL & EXTERIOR DUST SAMPLES FOR LEAD AND ARSENIC

Preparation:

1. Oven dry samples overnight at 105° Centigrade.

2. Desiccate 1 hour till cool thoroughly mix before weighing.

3. Weight out 0.1 g (nearest milligram) into a pre-labeled, acid washed 100 ml beaker.

Digestion:

1. The reagents being used are 1M and 7M reagent nitric acid prepared with distilled deionized water.

   1M = 64 ml HNO_3/1 liter D.D. H_2O (volumetric)
   7M = 898 ml HNO_3/2 liter D.D. H_2O (volumetric)

   Measure conc. acid in a graduated cylinder. Pour acid slowly into a volumetric half-filled with water, frequently swirling. Make up to volume.

   Make up solution 1 day prior to use to allow for cooling of acid, then bring back up to volume.

2. To each sample, add 25 ml of 7M HNO_3 using a repeater pipette dispenser or acid buret. Wash down the sides of the beaker.

3. Cover each beaker with a ribbed watchglass, place samples on hot plate at 120 Centigrade for 2 hours. For Arsenic samples stay at 100° Centigrade throughout procedure.

4. Remove the samples from the hot plate and cool in hood until they are at room temperature.

5. The entire filtration procedure should take place under the hood. Use a wash bottle filled with 1M HNO_3 for rinsing. Set up glass funnels over 100 ml pre-labeled beakers. In each funnel, place a folded whatman #54 filter paper. Before filtering, wet filter paper and rinse glassware with about 20-30 ml of 1M HNO_3. Discard waste rinse. To filter, decant the liquid from the sample first, then pour the solids onto the filter. Once this has drained, wash the beaker with 3 small (3 ml) portions of 1M HNO_3. After the filter paper is thoroughly drained it is discarded. Rinse the glass funnel with one small portion of 1M HNO_3.

6. Re-cover samples with watchglasses and place on a hot plate at 180° Centigrade to evaporate down to dryness. Remove samples just at dryness to avoid burning. For

Arsenic samples temperature is 100° Centigrade and can be left overnight to go down to dryness.

7. To re-dissolve lead, add 3 ml of 1M HNO_3 (using Pasteur pipets), rinsing down sides of beakers.

8. Re-cover beakers with watchglasses and put on hot plate at 120° Centigrade for a few minutes (5-10 min) to mildly heat, some of the 3 ml may evaporate.

9. Cool the samples to room temperature. Pour the remaining sample into a 10 ml labeled centrifuge tube. Rinse the beaker 3 times with 1M HNO_3 from a Pasteur pipette. Each rinse should be about 1 ml. Keep in mind the total volume is 10 ml. Bring sample up to volume, shake thoroughly.

10. Samples are then submitted to the A.A.S. lab for determination of lead or arsenic. Samples are now 6.4% nitric acid.

R. NITRIC/PEROXIDE EXTRACTION FOR PAINT SAMPLES

Preparation:

1. Oven dry samples overnight at 105° Centigrade.

2. Desiccate 1 hour till cool, thoroughly mix before weighing.

3. Weigh out 0.1 g (nearest milligram) into a pre-labeled, acid washed 100 ml beaker.

Digestion:

Should take place under the hood.

1. Add 3 ml concentrated HNO_3 and 1 ml 30% H_2O_2 cover with ribbed watchglass.

2. Heat on hot plate at 140° Centigrade until most of the acid has evaporated, remove from heat and allow to cool.

3. Add 2 ml concentrated HNO_3 and 1 ml 30% H_2O_2, take down to near dryness, remove from heat and cool.

4. Repeat step 3 one more time, remove samples near dryness and allow to cool.

5. Rinse watchglass and walls of beaker with 3 to 5 ml of 10% HNO_3. Allow the solution to evaporate gently to dryness, remove from heat and cool.

6. Add 1 ml concentrated HNO_3 to residue swirl sample to dissolve soluble species.

7. Next add 40-50 ml of Deionized/distilled water to 1 ml conc. acid solution. Swirl sample and place back onto hot plate for 1 hour to gently heat at 140° Centigrade. Remove and cool sample. The remainder of procedure will be finished using D.D. H_2O.

Filtration:

Should take place under the hood.

1. Set up glass over 100 ml prelabeled, acid washed beakers. In each funnel, place a folded Whatman #54 filter paper. Using wash bottle with D.D. H_2O wet filter paper and rinse glassware with about 20-30 ml of water. Discard waste rinse.

2. To filter, decant liquid from sample first, then pour the solids on top the filter. Once this has drained, wash beaker thoroughly with 3 rinsings, adding each rinse to filter paper. Rinse the filter paper 3 times also with H_2O. Once filter paper has thoroughly drained. It is discarded. Rinse glass funnel with small portion of H_2O.

3. Pour the sample from beaker into labeled 100 ml graduated cylinder, rinse beaker thoroughly. Bring sample up to 100 ml total volume, stopper cylinder and mix vigorously. Pour sample into prelabeled, acid washed 125 ml wide mouth Nalgene bottle.

4. Submit samples to A.A.S. lab for determination of lead. Samples are now 1% in nitric acid.

W. THE DETERMINATION OF LEAD IN ENVIRONMENTAL SAMPLES

Description

A 10 ml digested interior dust, dustfall, or handwipe sample is submitted for analysis. After direct analysis of the sample by flame atomic absorption spectrophotometry. All interior dust samples that show up found Pb levels of 9 µg or less will be set aside for a more precise analysis by MIBK extraction. The lead is dithiocarbamate complex and is analyzed by using flame AA.

I. <u>Analytical Procedure</u>

A. Reagents

All chemicals are ACS Reagent Grade, or equivalent unless otherwise specified.

1. Ammonium Hydroxide

2. Concentrated Nitric Acid

3. Phenol Red Indicator Solution (0.04% w/v in water)

4. Aqueous Potassium Cyanide (10% w/v)

Caution: Avoid acid. Will form poisonous gas under acid conditions.

5. Aqueous Ammonium Pyrrolidine Dithiocarbamate (2% w/v). Prepare fresh daily.

6. Methyl Isobutyl Ketone

Saturate with water by shaking 250 ml of MIBK with 5 ml of water immediately prior to use.

7. Ammonium Citrate Buffer (pH = 8.4)

Place 1200 g of citric acid in a 4 liter beaker. Add 900 ml of water and 50 drops of phenol red indicator solution (see above). Add ammonium hydroxide until all the citric acid has dissolved and the solution has a definite pink color (pH = 8.4). Cool and adjust the final volume to 3000 ml.

B. Equipment

1. Perkin-Elmer Model 5000 Atomic Absorption Spectrophotometer, or equivalent.

2. A set of 50 ml volumetric flasks reserved for the chelation/extraction procedure.

II. Direct Analysis Procedure

1. Analyze digested 10 ml sample using flame AA by water aspiration.

2. Turn on the Perkin-Elmer Model 5000 (or 2380) Atomic Absorption Spectrophotometer and allow to warm up for 45 minutes prior to use.

3. Light to hollow cathode lamp. Adjust the wattage to that recommended on the lamp (*e.g.*, 10 watts). Allow to warm up for 15 minutes. If a electrodeless discharge lamp is being used, set the current (mA) to that recommended on the lamp and allow to warm up for 45 minutes.

4. Tweak up the wavelength (217.0 nm) for maximum light throughput (energy).

5. Set the following line pressures: air = 64.0 acetylene = 30.

6. Optimize the burner position for maximum absorbance while aspirating a 10 ppm solution of lead in 10% (v/v) nitric acid.

7. Start the stripchart (20 mm/min & 10 mv).

8. Activate AA/BG (background correction with Atomic Absorption).

9. Allow 15 min. to warm up.

10. When stable baseline has been achieved start analysis.

11. Use standard run order, aspirate standard blank, 1 ppm, 5 ppm, 7 ppm, 10 ppm , and standard blank. Then aspirate 5 ppm NIST, 10 ppm and standard blank then aspirate 7 ppm and standard blank.

12. Start aspirating samples and allow enough time between to achieve baseline.

13. After every 10 samples aspirate one of the standards this should agree within 5$ of the previous response. If okay go ahead. If not respirate all the standards and reaspirate the 10 samples again and run 1 standard.

14. Any samples that respond over 9 ppm set aside for later dilution.

15. For every 25 samples there is one sample selected for duplication.

16. For every 20 samples there is one sample selected for recovery: (a) take 1 ml of 1 ppm of Pb standard and aspirate.

17. When all samples have been aspirated in standard run order. Aspirate 5 ppm NIST then aspirate all the standards again.

18. Samples that need dilution must be roughly determined using high standards and then diluted appropriately. a) then they can be analyzed using lower standards.

Calculations

1. Plot the measured peak height from the strip chart *vs.* the amount of lead added to each standard solution.

2. Measure the peak height in millimeters for each sample.

3. Translate the measured sample peak height into an equivalent number of micrograms by means of the calibration curve. This gives the amount of lead in the original sample (g/ml).

4. Multiple ug/ml by initial volume (10 ml) to achieve µg found.

5. All interior dust samples that show µg found Pb levels of 9 µg or less will be set aside for MIBK extraction.

6. All dustfall samples that show µg found Pb levels of 3 µg or less will be set aside for MIBK extraction.

7. Recoveries measured by (orig. sample + 1)/2 x 100% = Rec.%

III. Extraction Procedure

Once extracted the samples are stable for approximately 6 hours.

1. Transfer the measured pre-direct analyzed solution to a 50.0 ml volumetric flask with the total solution volume including rinsings not to exceed 25 ml.

2. Add 5.0 ml of the ammonium citrate buffer and 3 drops of 0.04% phenol red indicator solution.

3. Add ammonium hydroxide dropwide to adjust the pH to 8.2 (vivid pink from bright yellow, approximately 50 drops)

   NOTE: phenol red is pale pink at very acid pH as would be encountered initially. During pH adjustment, the sample will change from pink to bright yellow to vivid pink.

   CAUTION: THE SOLUTION MUST BE BASIC BEFORE PROCEEDING

EE. XRF ANALYSIS OF SOIL AND EXTERIOR DUST FOR LEAD AND ARSENIC

Sample Drying:

The soil sample in the bag is desegregated by crushing with gloved hand or with a stainless steel spoon. The entire sample is poured from the bag onto a 6" or 9" plastic plate, that has been labeled with corresponding lab number.

The plate is covered lightly with paper towels. Soil must be air dried until a constant weight is achieved (can be up to 5 days). All records of drying dates and weights are logged in a lab notebook.

Sample Sieving:

All sieving takes place under a hood with the exhaust fan operating.

Obtain 2 clean sieve pans, 2 mm sieve, and 250 µm sieve. Place the 2 mm sieve on one pan. Pour the entire dry sample into the sieve. The entire sample should be passed through the sieve, using a stainless steel tool such as a spatula or spoon to desegregate particles.

The stones and other material larger than 2 mm may be discarded.

The fraction that passes the 2 mm sieve is now called the *fraction 1 & 2 and is stored in plastic bags.

The material in the sieve pan (Total Soil Fraction) is place in a pre-labeled glass storage jar, (Quorpak, 4 oz.) Stir the soil in the sieve pan well and remove an aliquot of the soil.

The remainder of the soil in the sieve pan is placed in the 250 um sieve on a second clean sieve pan. By gently desegregating the soil with a stainless steel tool such as a spatula or spoon, and by shaking the pan, work the soil through the sieve until it appears that no more material is passing through. The portion that does not pass the 250 um sieve may be discarded. The soil inn the sieve pan is placed in a pre-labeled glass storage jar. This fraction will be identified as the "Urban Soil Fraction" (U).

Cleaning of Sieves:

Sieves are cleaned between samples by tapping on a hard surface, brushing out, and inspecting for remaining particles. Same "blinding" of the sieve is inevitable, as particles become lodged in the screen.

Drying Samples to Constant Weight:

The samples are weighed on a 2-place analytical balance and the weight recorded in a drying record notebook. Samples are considered at constant weight when 2 successive weighings have recorded less than 0.5g difference (less than -0.5%). Drying between weighings may be done with a minimum of 2 hours in a drying oven (max temperature 105°C) or a 24 hour air drying period.

Aliquoting Samples for Analysis:

Care should be taken to thoroughly mix the sample by tumbling and stirring before removing the aliquot for analysis.

XRF Analysis for Lead

Approximately 2g of loose sieved soil will be weighed and placed into labeled sample cup (Chemplex Industries, Inc., Cat. No. 1530), fitted with windows of ¼ mil thick X-ray polypropylene film (Chemplex Industries, Inc., Cast. No. 425).

The instrument configuration for the Kevex Delta Analyst Energy Dispersive X-ray Spectrometer is:

1. Kevex Analyst 770 Excitation/Detection Subsystem:

    a. X-ray tube: Kevex high output rhodium anode

    b. Maximum power supply: Kevex 60 kv, 3.3 mA

    c. Detector/cryostat: Kevex Quantum - UTW lithium, drifted silicon. 165 eV FWHM resolution at 5.9 KeV

2. Kevex Delta Analyzer:

a. Computer mainframe: Digital Equipment Corp. PDP 11/73

b. Computer software: Kevex XRF Toolbox II, Version 4.14

c. Disk drives: Iomega Bernoulli box, dual drives, 20 MB

d. Pulse processor: Kevex 4460

e. Energy to digital converter: Kevex 5230

3. Operating conditions:

a. Excitation Mode: Mo secondary target with 4 mil thick Mo filter

b. Excitation conditions: 30 kV, 0.5 mA

c. Acquisition time: 200 livetime seconds

d. Shaping time constant: 7.5 microseconds

e. Sample chamber atmosphere: air

f. Detector collimator: Ta

4. Analytical conditions:

a. Escape peaks, and background are removed from all spectra

b. The intensity ratio, defined as the integral of counts in the Pb (LB) window divided by the integral of the counts in the MO (KA) Raleigh scatter window, are determined for each spectrum

c. The intensity ratios for the standards are used to determine a linear least squares calibration curve.

5. Calibration standards:

The following Cincinnati Soil and EMSL Las Vegas Standards used to produce two calibration cures. Sample concentration is determined using the calibration curve in which its intensity ratio falls. The two curves consist of concentration ranges of 11-4, 142 ppm and 4, 142-21, 867 ppm. The standards were analyzed by an SRF analysis done in the EMSL Las Vegas lab.

<u>ppm Pb</u>

11
40
175
423
752
1,040
2,446
4,142
13,885
21,867

6. Calibration check:

The 175 and 1, 040 ppm standards will be used as calibration checks.

XRF Analysis for Arsenic

Approximately 2g of loose sieved soil will be weighed and placed into labeled sample sups (Chemplex Industries, Inc., Cat. No. 1530), fitted with windows of ¼ mil thick X-ray polypropylene film (Chemplex Industries, Inc., Cat. No. 425)

The instrument configuration for the Kevex Delta Analyst Energy Dispersive X-ray Spectrometers is

1. Kevex Analyst 770 Excitation/Detection Subsystem:

END OF ATTACHMENT A

Appendix B
The complete Bornschein dataset

Table B-1
1994 University of Cincinnati Data Set

ST NO	ST NAME	TYPPROP	DFALLDAY	WTMATFIN	TOTWTMAT	MAT DAY	DFALLGMS	XRFPB P	XRFPB C	XRFPB X	XRFPB Y	PAINTPPM
2030	BENTON	C	28	0.02	1.89	14	0.25	298	373	224	2463	.
2146	DELMAR	C	30	.	.	.	0.13	2729	288	1194	217	136342
2124	EDISON	C	32	9.43	17.8	27	0.05	1513	189	1746	320	6933
2128	EDISON	C	30	.	.	.	0.09	650	148	181	319	16344
1410	GRAND	PR	31	27.55	38.18	27	0.08	32	2159	218	550	.
1412	GRAND	R	31	40.04	46.47	21	0.08	3635	2243	1076	659	.
1413	GRAND	A	31	.	.	.	0.09	1215	2182	284	608	.
1415	GRAND	R	31	.	.	.	0.08	1089	1782	190	565	.
1417	GRAND	A	31	0.48	1.3	25	0.16	910	2371	845	606	.
1418	GRAND	R	31	9.55	12.73	21	0.09	2065	4840	3368	334	2928
1419	GRAND	PR	31	.	.	.	0.16	1312	3124	1094	776	27476
1424	GRAND	R	32	0.96	2.65	20	0.34	2852	2869	3253	469	23059
1425	GRAND	A	31	1.35	2.9	19	0.07	2210	1531	614	681	.
1429	GRAND	R	32	19.05	35.31	20	1.45	2330	2193	2350	443	.
1431	GRAND	R	36	14.37	18.25	36	2.63	1250	2247	1705	665	157000
1436	GRAND	R	36	7.73	5.89	36	0.11	938	2967	753	1045	.
1437	GRAND	A	32	4.74	7.79	27	0.07	14238	2240	1220	416	.
1438	GRAND	R	34	.	.	.	0.04	10373	1838	72496	1102	40496
1440	GRAND	R	.	5.87	13.12	20	.	2105	2281	1160	675	.
1442	GRAND	PR	.	.	.	.	.	34	213	.	569	.
1443	GRAND	PR	32	4.58	8	25	0.11	630	1133	1500	712	.
1447	GRAND	A	33	.	.	.	0.09	2780	3781	651	705	.
2129	GRAND	C	33	.	.	.	0.07	1757	526	1415	228	178
1413	MADISON	AR	19	.	.	.	0.09	30	190	773	171	41488
1415	MADISON	AR	19	.	.	.	0.04	28	90	511	164	.
1425	MADISON	R	32	6.05	12.77	27	0.14	1868	1420	2424	183	28549
1429	MADISON	PR	33	2.36	4.47	33	0.26	104	2351	1107	145	.
1433	MADISON	A	33	.	.	.	0.11	1359	1331	7635	179	56555
1439	MADISON	A	33	10.03	11.58	33	0.39	2333	1829	1210	216	2104
1441	MADISON	A	.	.	.	.	.	2715	226	.	.	.
1400	STATE	A	30	1.95	5.71	25	0.16	1787	2025	788	556	.
1406	STATE	AR	.	.	.	.	.	26	24	.	.	.
1408	STATE	PR	.	.	.	.	.	48	125	551	277	.
2142	STATE	C	31	0.56	2.39	21	0.03	1879	571	438	521	56713
2158	STATE	C	33	1.45	3.82	19	0.05	400	420	368	318	.

Table B-1
1994 University of Cincinnati Data Set

ST NO	ST NAME	PBPPM D	DFALLPPM	XRFPB Z	PBPPMMAT	FL AREA	TOTWT X	WT D	MAXINT P	MAXEXT P	PAINTPOS	ENT AREA	ST AREA
2030	BENTON	403	176	.	594	1250	30	285	0.3	0.2	0	2	2
2146	DELMAR	.	1920	55	.	.	147	.	.	44.3	87.5	2	2
2124	EDISON	1141	4011	95	1631	1875	228	84	27.1	9.4	44.4	2	2
2128	EDISON	.	326	192	.	.	21	.	.	1.1	0	2	2
1410	GRAND	480	694	195	439	1875	24	144	0.5	1.8	11.1	2	2
1412	GRAND	608	611	143	148	2550	122	11	3.6	10.1	66.7	2	2
1413	GRAND	.	622	253	.	.	30	.	.	1.7	33.3	2	2
1415	GRAND	1070	454	154	.	2500	22	290	0.7	18.1	22.2	2	2
1417	GRAND	890	908	309	596	1875	102	138	3	.	44.4	2	2
1418	GRAND	109	513	52	115	2500	385	82	39.2	38.6	55.6	2	2
1419	GRAND	4878	880	224	.	1875	126	460	1.8	17.3	37.5	2	2
1424	GRAND	462	2494	87	2355	2500	364	14	2.3	13.2	44.4	2	2
1425	GRAND	839	432	272	277	2500	67	27	6.2	31.9	23.1	2	2
1429	GRAND	6385	1141	444	1878	3125	285	295	0.5	28.3	11.1	2	2
1431	GRAND	1094	21	.	283	2500	192	1170	2.5	21.8	36.4	2	2
1436	GRAND	258	2091	59	648	1875	84	2000	5.5	9.1	55.6	2	2
1437	GRAND	2684	896	827	1378	1875	138	6000	3.3	1.7	33.3	2	2
1438	GRAND	.	4863	86	.	.	8250	.	.	17.1	50	2	2
1440	GRAND	442	.	105	364	2500	124	212	2.9	3.2	44.4	2	2
1442	GRAND	.	.	.	.	.	.	.	.	.	.	.	1
1443	GRAND	1462	974	299	396	1875	156	120	0.9	2.8	30	2	2
1447	GRAND	1155	1400	388	.	1875	67	625	12.6	6.2	44.4	2	2
2129	GRAND	.	376	202	.	.	165	.	0.1	14.6	22.2	2	2
1413	MADISON	.	64378	946	.	.	84	.	.	.	.	2	2
1415	MADISON	.	4060	102	.	.	56	.	.	8.9	75	2	2
1425	MADISON	655	2966	71	877	2500	343	100	5.5	18.9	44.4	2	2
1429	MADISON	.	859	104	3635	.	132	.	.	39.8	33.3	2	2
1433	MADISON	.	710	.	.	.	820	.	.	7.7	25	2	2
1439	MADISON	.	36990	98	8636	.	138	.	.	1.8	25	2	2
1441	MADISON	.	.	.	.	.	.	.	.	.	.	.	2
1400	STATE	551	527	428	546	1875	92	46	0.2	1.3	14.3	2	2
1406	STATE	377	.	.	.	2500	.	27	2.5	0.4	9.1	2	.
1408	STATE	638	.	340	.	2500	64	156	1.3	0	22.2	2	2
2142	STATE	403	540	415	589	1925	23	10	4.4	18.1	44.4	2	2
2158	STATE	365	634	399	471	1875	39	63	2	1.2	11.1	2	2

Table B-1
1994 University of Cincinnati Data Set

ST_NO	ST_NAME	ALL_AREA	DFALLRAT	MATPB_LD	PBLOAD_D	PBLOAD_X
2030	BENTON	.	382.64	50.24	2280	240
2146	DELMAR	1	.	.	.	1176
2124	EDISON	1	1098.76	33728.34	448	1824
2128	EDISON	1	.	.	.	168
1410	GRAND	1	283.47	26522.56	768	192
1412	GRAND	1	192.91	16708.2	43.14	976
1413	GRAND	1	.	.	.	240
1415	GRAND	1	149.78	.	1160	176
1417	GRAND	1	736.99	677.55	736	816
1418	GRAND	1	189.39	3096.53	328	3080
1419	GRAND	1	723.48	.	2453.33	1008
1424	GRAND	1	3235.71	6693.07	56	2912
1425	GRAND	1	122.16	1165.34	108	536
1429	GRAND	1	5021.84	105914.1	944	2280
1431	GRAND	.	186.64	6688.58	4680	1536
1436	GRAND	1	1018.32	8238.44	10666.67	672
1437	GRAND	1	304.54	14323.75	32000	1104
1438	GRAND	1	.	.	.	66000
1440	GRAND	1	.	6325.61	848	992
1442	GRAND	.	.	.	.	.
1443	GRAND	1	518.81	4295.5	640	1248
1447	GRAND	1	619.82	.	3333.33	536
2129	GRAND	1	.	.	.	1320
1413	MADISON	1	.	.	.	672
1415	MADISON	1	.	.	.	448
1425	MADISON	1	1579.86	11635.48	400	2744
1429	MADISON	1	.	15392.02	.	1056
1433	MADISON	.	.	.	.	6560
1439	MADISON	1	.	155414.9	.	1104
1441	MADISON	1	.	.	.	.
1400	STATE	1	453.41	2521.62	245.33	736
1406	STATE	.	.	.	108	.
1408	STATE	1	.	.	624	512
2142	STATE	1	77.12	929.99	51.95	184
2158	STATE	1	152.82	2128.28	336	312

Table B-1
1994 University of Cincinnati Data Set

Notes	
ST_NO	Street number
ST_NAME	Street name
TYPPROP	Type of Property (PR = previously remediated, A = adjacent, AR = immediately after remediation, R = prior to remediation, C = control)
DFALLDAY	Days of dust fall accumulation
WTMATFIN	Weight of seived entry mat dust (g)
TOTWTMAT	Weight of dust on entry mat
MAT_DAY	Days of dust accumulation on entry mat
DFALLGMS	Weight of dustfall (g)
XRFPB_P	Perimeter soil lead concentration (ppm)
XRFPB_C	Curb soil lead concentration (ppm)
XRFPB_X	Concentration of lead in exterior entry dust (ppm)
XRFPB_Y	Concentration of lead in street dust (ppm)
PAINTPPM	Paint lead concentration (ppm)
PBPPM_D	Concentration of lead in interior floor dust
DFALLPPM	Concentration of lead in dustfall container (ppm)
XRFPB_Z	Concentration of lead in alley dust (ppm)
PBPPMMAT	Concentration of lead in interior entry mat dust (ppm)
FL_AREA	Floor area sampled (cm2)
TOTWT_X	Entry dust weight
WT_D	Floor dust weight
MAXINT_P	Maximum interior lead paint loading (mg/cm2)
MAXEXT_P	Maximum exterior lead paint loading (mg/cm2)
PAINTPOS	% of painted surfaces tested positive for lead
DFALLRAT	Exterior dust fall lead loading per month (ug/m2/month)
MATPB_LD	Mat dust lead loading per month: transfer rate (ug/m2/month)
PBLOAD_D	Interior floor dust lead loading (ug/m2)
PBLOAD_X	Exterior dust lead loading (ug/m2)

Table B-2
1995 University of Cincinnati Data Set

Street #	Street	Area	Building	Family	Apartment	Perimeter soil lead (ug/g)		Curb soil lead (ug/g)	
						Initial	Repeated	Initial	Repeated
1630	CLEVELAND	G	0031	1	0000	109		2879	
1640	CLEVELAND	G	0032	1	0000	146		2738	
1642	CLEVELAND	G	0040	1	0000	667		3291	
1728	CLEVELAND	G	0025	1	0002	120		1074	
1621	DELMAR	G	0028	1	0000	222		3780	
1624	DELMAR	G	0042	1	0000	118		4695	
1628	DELMAR	G	0041	1	0000	66		3665	
1633	DELMAR	G	0024	1	0000	357		3433	
1635	DELMAR	G	0023	1	0000	1180		3420	
1636	DELMAR	G	0037	1	0000	46		2068	
1636	DELMAR	G	0038	1	REAR	74		2068	
1638	DELMAR	G	0039	1	0000	63		2647	
1640	DELMAR	G	0043	1	0000	82		2016	
1641	DELMAR	G	0015	1	0000	125		1448	
1627	EDISON	G	0026	1	0000	59		2261	
1643	EDISON	G	0022	1	0000	101		1817	
1401	GRAND	G	0033	1	0000	219		127	
1410	GRAND	G	0001	1	0000	56		1283	
1412	GRAND	G	0007	1	0000	222		29	
1415	GRAND	G	0020	1	0000	670	575	31	31
1418	GRAND	G	0008	1	0000	490		85	
1419	GRAND	G	0012	1	0000	654		60	
1422	GRAND	G	0034	1	0000	218		51	
1424	GRAND	G	0002	1	0000	38		64	
1429	GRAND	G	0036	1	0000	75		47	
1431	GRAND	G	0006	1	0000	767	1703	71	88
1436	GRAND	G	0011	1	0000	2158		71	
1438	GRAND	G	0010	1	0000	4154		2094	
1443	GRAND	G	0003	1	0000	3845		764	
1411	MADISON	G	0021	1	0000	84		68	
1413	MADISON	G	0017	1	0000	69		53	
1415	MADISON	G	0018	1	0000	681		76	
1419	MADISON	G	0030	1	0000	342	276	80	62
1423	MADISON	G	0035	1	0000	48		844	
1425	MADISON	G	0029	1	0000	82		1448	
1429	MADISON	G	0013	1	0000	117		1754	
1406	STATE	G	0014	1	0000	42		135	
1408	STATE	G	0019	1	0000	47		158	

Table B-2
1995 University of Cincinnati Data Set

Street #	Street	Mid-yard soil lead (ug/g)		Exterior dust sample				Exterior dust sample repeated	
		Initial	Repeated	Total weight (g)	Lead conc. (ug/g)	Dust loading (g/m2)	Dust lead loading (ug/m2)	Total weight (g)	Lead conc (ug/g)
1630	CLEVELAND	142		2.47	2,493.70	13.29	33,149.82		
1640	CLEVELAND	92		0.33	1,329.50	0.89	1,180.63		
1642	CLEVELAND	88		4.27	931.10	22.98	21,397.56		
1728	CLEVELAND	51		1.30	824.30	7.00	5,767.25		
1621	DELMAR	354		7.03	1,566.20	18.92	29,628.70		
1624	DELMAR	42		18.69	122.20	100.59	12,291.94		
1628	DELMAR	100		4.50	1,090.60	24.22	26,413.02		
1633	DELMAR	70		1.51	5,495.50	5.42	29,773.71		
1635	DELMAR	689		2.99	1,408.90	16.09	22,672.08		
1636	DELMAR	68		0.96	1,315.80	5.17	6,798.31		
1636	DELMAR	47		6.31	1,566.70	33.96	53,205.35		
1638	DELMAR	44		0.65	1,002.80	3.50	3,508.07		
1640	DELMAR	28		3.64	3,080.80	19.59	60,353.85		
1641	DELMAR	116		11.11	669.20	59.79	40,013.83		
1627	EDISON	44		1.79	407.30	9.63	3,923.81		
1643	EDISON	43		1.57	1,403.00	8.45	11,854.89		
1401	GRAND	62		9.79	15,103.40	52.69	795,788.20		
1410	GRAND	27		16.94	326.70	91.17	29,785.34		
1412	GRAND	30		25.05	1,524.70	134.82	205,556.97		
1415	GRAND	28	31	9.44	276.20	50.81	14,032.52	3.49	376.50
1418	GRAND	35		3.76	1,747.40	20.24	35,360.65		
1419	GRAND	38		38.87	2,322.50	209.20	485,859.10		
1422	GRAND	30		3.70	30,555.60	19.91	608,460.82		
1424	GRAND	23		13.19	2,268.60	70.99	161,043.35		
1429	GRAND	88		23.93	1,987.60	128.79	255,983.38		
1431	GRAND	53	41	3.89	2,479.00	20.94	51,899.86	2.08	1,317.20
1436	GRAND	158		6.50	1,703.50	34.98	59,593.04		
1438	GRAND	1770		32.88	18,822.40	176.96	3,330,787.19		
1443	GRAND	4257		48.57	707.60	261.40	184,967.75		
1411	MADISON	30		0.72	7,819.30	3.88	30,299.85		
1413	MADISON	27		44.76	2,170.50	240.90	522,865.45		
1415	MADISON	32		3.01	2,057.80	16.20	33,335.71		
1419	MADISON	60	29	11.82	2,208.50	63.61	140,493.09	5.65	2,328.80
1423	MADISON	43		10.40	1,703.30	55.97	95,337.68		
1425	MADISON	140		49.83	803.50	268.18	215,484.90		
1429	MADISON	84		37.78	1,771.20	203.33	360,138.57		
1406	STATE	46		10.39	812.20	55.92	45,417.02		
1408	STATE	44		19.52	1,284.60	105.06	134,954.64		

Table B-2
1995 University of Cincinnati Data Set

Street #	Street	Interior dust sample					Interior dust quality control sample		
		Total weight (g)	Lead (ug)	Lead conc. (ug/g)	Dust loading (g/m2)	Dust lead loading (ug/m2)	Total weight (g)	Lead (ug)	Lead cor (ug/g)
1630	CLEVELAND								
1640	CLEVELAND								
1642	CLEVELAND	0.03	21.0	642.2	0.17	112.00			
1728	CLEVELAND	0.12	72.0	618.6	0.62	384.00			
1621	DELMAR	0.09	102.0	1,075.9	0.51	544.00			
1624	DELMAR	0.20	147.0	720.2	1.09	784.00			
1628	DELMAR	0.21	52.0	251.5	1.10	277.33			
1633	DELMAR	0.03	36.0	1,353.4	0.14	192.00			
1635	DELMAR	0.03	12.0	415.2	0.15	64.00			
1636	DELMAR	0.21	110.0	531.1	1.10	586.67			
1636	DELMAR	0.05	30.0	600.0	0.27	160.00			
1638	DELMAR	0.03	11.0	347.0	0.17	58.67			
1640	DELMAR	0.10	28.0	281.4	0.53	149.33			
1641	DELMAR	0.26	211.2	804.9	1.40	1,126.40			
1627	EDISON								
1643	EDISON	0.02	7.1	327.2	0.12	37.87			
1401	GRAND								
1410	GRAND	0.16	34.0	216.0	0.84	181.33			
1412	GRAND	0.17	108.0	651.8	2.65	1,728.00			
1415	GRAND	0.02	6.6	302.8	0.12	35.20	0.02	6.1	264.1
1418	GRAND	0.05	24.0	521.7	0.25	128.00			
1419	GRAND								
1422	GRAND	0.07	96.0	1,463.4	0.35	512.00			
1424	GRAND	0.03	23.0	782.3	0.16	122.67			
1429	GRAND								
1431	GRAND	0.04	35.0	958.9	0.19	186.67	0.1	82	863.2
1436	GRAND								
1438	GRAND								
1443	GRAND	0.02	10.0	448.4	0.12	53.33			
1411	MADISON								
1413	MADISON								
1415	MADISON	0.02	11.0	569.9	0.10	58.67			
1419	MADISON	0.02	15.0	943.4	0.08	80.00	0.03	29	976.4
1423	MADISON	0.05	38.0	742.2	0.27	202.67			
1425	MADISON								
1429	MADISON								
1406	STATE	0.04	12.0	319.1	0.15	48.00			
1408	STATE								

Table B-2
1995 University of Cincinnati Data Set

Street #	Street	Interior dust field blank			First paint chip sample			Second paint chip sample		
		Total weight (g)	Lead (ug)	Lead conc. (ug/g)	Total weight (g)	Lead (ug)	Lead conc. (ug/g)	Total weight (g)	Lead (ug)	Lead conc (ug/g)
1630	CLEVELAND				0.07	830	12,029.0	0.30	180	599.4
1640	CLEVELAND				0.49	3,570	7,244.3	0.33	16,200	48,765.8
1642	CLEVELAND				0.46	8,400	18,300.7			
1728	CLEVELAND				0.19	570	3,048.1			
1621	DELMAR									
1624	DELMAR				0.47	47,000	99,808.9			
1628	DELMAR				0.44	50,000	114,547.5			
1633	DELMAR				0.71	53,100	74,453.2	0.10	10	96.1
1635	DELMAR									
1636	DELMAR				0.56	60	107.9			
1636	DELMAR									
1638	DELMAR									
1640	DELMAR									
1641	DELMAR									
1627	EDISON				0.37	39,750	106,797.4	0.88	10,500	11,900.7
1643	EDISON				0.12	250	2,061.0	0.77	840	1,093.6
1401	GRAND				0.68	76,950	113,848.2	0.39	184,500	471,987.7
1410	GRAND				0.03	30	1,052.6	0.19	250	1,319.3
1412	GRAND				0.18	13,500	74,750.8	0.13	1,040	8,106.0
1415	GRAND		0.10							
1418	GRAND				0.40	130,000	321,066.9			
1419	GRAND				0.25	8,400	33,898.3			
1422	GRAND				0.65	91,800	141,230.8	0.48	38,250	78,866.0
1424	GRAND				0.14	650	4,662.8			
1429	GRAND				0.50	79,650	160,617.1	1.70	30,600	18,032.9
1431	GRAND		0.10		0.57	4,500	7,865.8	0.28	43,200	154,617.0
1436	GRAND				0.31	1,560	4,987.2	0.44	310	701.4
1438	GRAND				0.80	136,000	169,049.1			
1443	GRAND									
1411	MADISON				1.02	5,310	5,207.4	1.02	32,400	31,827.1
1413	MADISON				0.50	69,600	140,350.9	0.85	58,500	68,670.0
1415	MADISON				0.14	330	2,370.7			
1419	MADISON		0.10		0.92	15,600	17,019.4			
1423	MADISON				0.28	10,500	37,661.4	0.59	15,600	26,231.7
1425	MADISON				0.48	68,250	143,081.8			
1429	MADISON				0.10	16,500	157,743.8	0.44	121,800	279,807.0
1406	STATE				0.40	210	529.4	0.11	110	959.9
1408	STATE				0.10	470	4,648.9	0.13	1,100	8,352.3

Table B-2
1995 University of Cincinnati Data Set

Street #	Street	Mat dust sample		Years after abatement	Soil lead conc. determined by EPA in 1991, 1992
		Total weight (g)	Lead conc. (ug/g)		Concentration expressed as ug/g
1630	CLEVELAND	3.08	429.1	2	2,120
1640	CLEVELAND	0.92	772.5	2	2,270
1642	CLEVELAND	2.11	508.0	2	1,220
1728	CLEVELAND	0.99	539.4	2	1,490
1621	DELMAR	0.60	784.3	2	
1624	DELMAR	1.56	790.7	2	1,460
1628	DELMAR	0.97	245.8	2	1,620
1633	DELMAR	0.36	171.3	2	2,260
1635	DELMAR	0.72	499.0	1	
1636	DELMAR	1.00	496.4	2	1,320
1636	DELMAR	1.50	377.9	2	
1638	DELMAR	0.29	474.1	2	1,300
1640	DELMAR	0.40	1,690.1	2	
1641	DELMAR	6.03	719.9	2	1,840
1627	EDISON			2	2,070
1643	EDISON	0.89	322.8	2	1,630
1401	GRAND			1	256
1410	GRAND	9.68	166.8	2	2,730
1412	GRAND	0.80	1,430.3	1	1,020
1415	GRAND	0.46	303.8	1	1,640
1418	GRAND	0.20	1,555.4	1	3,450
1419	GRAND			2	5,910
1422	GRAND	1.63	21,847.2	1	1,980
1424	GRAND	0.80	413.8	1	1,520
1429	GRAND			1	
1431	GRAND	1.92	1,643.8	1	
1436	GRAND			1	1,400
1438	GRAND	0.55	1,479.6	1	
1443	GRAND	1.29	728.1	2	1,970
1411	MADISON			1	
1413	MADISON	0.46	6,300.9	1	2,810
1415	MADISON	0.30	1,168.8	1	1,620
1419	MADISON	1.45	2,376.7	1	3,200
1423	MADISON	2.01	974.7	2	2,040
1425	MADISON			1	
1429	MADISON	1.44	834.1	2	1,920
1406	STATE	2.72	337.7	1	
1408	STATE			2	1,430

Table B-2
1995 University of Cincinnati Data Set

Lead Concentrations and loadings for street dust samples collected in August, 1995

Street #	Street Name	Conc. (ug/g)	Loading (mg/m2)	Location Adjacent to Taracorp Site
1600	State	498	1163	Yes
1600	Edison	1389	3721	Yes
1600	Delmar	2003	5733	Yes
1600	Cleveland	1738	2113	
1700	State	247	319	
1700	Edison	523	1553	
1700	Delmar	277	686	
1700	Cleveland	838	1614	Yes
1400	State	423	1625	Yes
1500	State	1210	2565	Yes
1400	Grand	286	825	
1500	Grand	592	2414	
1400	Madison	444	162	
1500	Madison	366	205	

Appendix C
EPA's Default Soil-to-Dust Transfer Coefficient of 70% is not Valid

The default assumption employed by EPA in its analysis of the potential benefits of soil remediation at Granite City is that interior housedust lead concentrations are equal to 70% of the concentration of lead in soil. That is, EPA assumes that the "soil-to-dust transfer coefficient" is 70%. This value is inconsistent with site-specific evidence collected by EPA. EPA found that the transfer coefficient value ranges from 0.29 for dwellings within 1/4 mile from the smelter to 0.55 ("distances to 3/8 mile") (Marcus, undated, p 63). For the entire community, EPA reported the soil-to-dust transfer coefficient to be 0.385. These values are consistent with the values reported in the literature.

Findings published in the literature also suggest that a transfer coefficient value of 70% is too high. Investigators have identified a wide range of plausible values for this coefficient. A structural equation model presented by EPA in the Agency's 1991 draft guidance for the IEUBK model (U.S. EPA, 1991, Figure B5-2) indicates the transfer coefficient is approximately 50%. Fergusson *et al.* (1986) used nine tracer elements to measure the extent to which exterior soil infiltrates homes and comprises interior housedust. The average ratio reported by this investigator was 0.44, suggesting a transfer coefficient of 44%. Moreover, in Fergusson's study, the results from the various tracers used were highly consistent, with a standard deviation of only 0.06. Fergusson and Kim (1991) reviewed a large number of earlier studies and compiled data based on 28 tracer elements (this review covered approximately 30 studies, including Fergusson *et al.* (1986)). Using values in the literature to estimate the concentration of these tracer elements in soil, and limiting attention to those tracers that were unlikely to be contaminated by interior house sources, Fergusson and Kim (1991) calculated that the ratio of the concentration of elements in housedust to the corresponding ratio of elements in soil was 0.33, corresponding to a transfer coefficient of 33%. Calabrese and Stanek (1992) concluded that the transfer coefficient was approximately 31%. Other studies in the literature have used structural equation modeling techniques. However, because these models are non-linear, it is not possible to infer a unique transfer coefficient from their results. In contrast, EPA's default transfer coefficient value is 70%.

Finally, the pre-abatement and post-abatement data from Granite City casts doubt on EPA's assumption that interior dust lead concentrations fall by 70 µg/g for every 100 µg/g that exterior soil lead

concentrations are decreased. Recall that the data in Table 5-4 in the main body of this report shows that interior dust lead concentrations both increase and decrease following abatement of exterior soil.